University of Alberta

Risk Perception, Behaviours and Attitudes Related to West Nile Virus in Alberta

by

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ABSTRACT

West Nile Virus (WNV) arrived in Alberta in 2003, and continues to be a public health concern. The thesis research, based on secondary analysis of data collected for a previous Alberta Health and Wellness survey, investigates WNV related public perceptions and behaviours in Alberta, along with willingness to support public health interventions. Self-perceived health status influenced both risk perception and engagement in personal protective measures associated with WNV. Risk perception had a significant impact on behaviours, consistently predicting the use of personal protective measures. Demographic variables were part of a complex relationship between attitudes and behaviours. Participation in a seroprevalence study (involving donation of a blood sample) was influenced by demographic characteristics (age, gender, and residence in an area with intense WNV activity). WNV education campaigns should be based on the periodical appraisal of risk perception to achieve targeted messaging and a more significant impact on behaviour change.

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LIST OF ABBREVIATIONS

AHW	Alberta Health and Wellness
CDC	Centre for Disease Control
DEET	N,N-diethyl-m-toluamide
HBM	Health Belief Model
HS	Self perceived health status
SARF	Social Amplification of Risk Framework
TB	Tuberculosis
TRA	Theory of reasoned action
TPB	Theory of planned behaviour
WNV	West Nile virus

1. INTRODUCTION

1.1. Background

The discovery of West Nile virus (WNV) in the United States in 1999 marked a dramatic change in the arthropod–borne virus disease ecology and epidemiology in North America. The expanding ecology and multifactorial biology of this arbovirus required public health officials to work in concert at a national level to respond to a WNV widespread epidemic. WNV poses a threat to both wildlife and domestic animals, registering high fatality rates among a variety of avian species and equines. The impact that WNV will have on wildlife, domestic animal and human population is still under evaluation. Since its initial appearance in New York in 1999 the virus has expanded rapidly throughout most of North America and it is expected to continue its spread. Surveillance therefore needs to be continued along with appropriate mosquito control measures and public education campaigns.

Moreover, the emergence of WNV infection as an epidemic of temperate and urban climates provides an example of how circumstances can broaden the scope and impact of an epidemic disease when new territory is affected. For example, it appears that more severe illness may arise within an immunologically-naïve population. The emergence of WNV thus constitutes a major public health concern in the US and Canada.

1.2. Study rationale

The arrival of WNV in Alberta in 2003 was associated with the virus detected in birds, mosquitoes, horses and humans. In total 435 birds, 31 mosquito pools and 172 horses tested positive. The distribution of WNV was characterized by strong clustering of positive mosquitoes, birds and horses in the Parkland and Grassland regions of the province. A total of 272 confirmed clinical cases were reported in Alberta during the 2003 season, from which 49 were the WNV neurological syndrome. The highest incidence of WNV cases was reported in Palliser Health Region, in the South-eastern part of the province (131 cases). In 2004, two human cases were detected, one travel related and one considered as locally acquired WNV neurological syndrome. Although the 2004 season in Alberta was characterized by a colder than average and more humid summer resulting in few human cases, WNV continues to be a public health concern.

In order to better understand the evolution of this emerging infectious disease, sustained surveillance efforts are needed, along with concurrent research in multiple areas: ecology and epidemiology, impact of disease in humans, risk perception and behaviours, public health preparedness and response. A successful public health intervention needs to be an evidence-based endeavour. Each intervention is based on in- depth understanding of the current knowledge in the area, but to ensure its success, mere replication of a previous effective action is not enough. Public health interventions should be tailored to local characteristics. For this reason, studies investigating public perceptions and behaviours, along with willingness to support public health interventions in Alberta will complement the information gained through regular surveillance of WNV and will assist public health officials in preventive, and control activities.

In the spring of 2004, following the first season of reported WNV activity in the province, Alberta Health and Wellness (AHW) conducted a WNV study aiming to estimate the seroprevalence of WNV among Albertans, and to assess knowledge, attitudes and behaviour related to WNV.

The current study, based on the analysis of the data collected during the above sero-survey aims to identify factors favouring participation in a public health intervention and to further investigate the attitudes and behaviours related to WNV among Albertans as a continuation of the analyses presented in the report of the Alberta Health and Wellness study.

1.3. Research design

1.3.1. Research questions

1. How does self-reported health status influence attitudes and behaviours related to WNV?
2. Which are the determinants of participation in a seroprevalence study (involving submission of a blood sample)?

1.3.2. Research approach and methods

1. Review of relevant literature in order to understand current knowledge in the area of risk perception, behaviours and attitudes related to West Nile virus.
2. Secondary analysis of data from the Alberta Health and Wellness West Nile Virus Seroprevalence Study, Alberta 2004 in order to gain in-depth understanding of WNV related behaviours and attitudes among Albertans.

1.3.3. Potential outcomes

This study was expected to:

- complement the findings from the AHW study,
- contribute to the validity of the seroprevalence estimate presented in the AHW study,
- enhance baseline surveillance data for WNV infection,
- assist in evaluation of effectiveness of public communication and awareness,
- assist in planning preventive strategies and focused control measures, and
- add to current knowledge of WNV epidemiology, risk perception and associated behaviours in the broad context of new emerging diseases.

2. LITERATURE REVIEW

This chapter aims to provide a background for the current study. It illustrates the status of WNV as a public health concern, and provides some relevant insights in the attitudinal and behavioural response to a disease threat, as described by socio- psychological research.

2.1. Epidemiology of WNV

2.1.1. The virus and its ecology

WNV has been classified as an arbovirus (which means that it is transmitted by an arthropod). WNV belongs to the Flavivirus family (along with other well known pathogens, yellow fever virus, from which the family name was derived, St. Louis encephalitis, dengue, Murray Valley encephalitis and Japanese encephalitis viruses).

WNV is one of the most widespread flaviviruses. Molecular epidemiologic studies revealed a large diversity of WNV strains corresponding to a wide geographical range including: Africa, Europe, Middle East, North America, Central America and Caribbean.

WNV is not a new virus. It has been known for many years. WNV had probably existed for a long time in Africa where it was discovered by chance, in 1937 in the blood of a woman from West Nile Province of Uganda (Smithburn et al. 1940), and since then it has been involved in both sporadic human cases and major epidemics in Africa, Middle East, Europe, Asia, and more recently in North America (see Box 1).

The first human epidemic was described in Israel in 1950, and the first large epidemic occurred in South Africa in 1974. The virus kept a low profile in the next 20 years, only to come back in the '90s in a more aggressive way. It has kept epidemiologists busy ever since.

Epidemics in Romania (1996) and Russia (1999) where characterized by urban locations, large number of cases with severe form of disease. In 1999 WNV arrived in a completely new territory: North America.

Both the new pattern of human urban epidemics and newly extended territory led to its recognition as an emerging pathogen. In the last decade, the emerging WNV has captured the attention of public health professionals and the public, and involved substantial economic costs (Zohrabian et al. 2004).

Box 1: WNV epidemics timeline

1937 -WNV first discovered in Uganda

1950 - first reported human epidemic in Israel

1974 - epidemic in South Africa

1996 - epidemic in Romania

1999 - epidemic in Russia
- WNV arrives in North America

2000 - epidemic in Israel

The virus has an avian reservoir. WNV is transmitted in cycles between birds and mosquitoes, particularly the Culex species (Figure1). Ornitophilic mosquitoes (feeding on birds) are the principal vectors of WNV, while many species of birds, especially migrants, act as hosts for the virus (Rappole et al. 2000). Infected birds have the ability to disseminate the virus into new territories, acting as introductory hosts. For the virus to become established in a new territory, several factors are necessary: appropriate climate, abundant presence of ornitophilic mosquito vectors and cross-species transmission to numerous indigenous birds, which act as amplifying hosts.

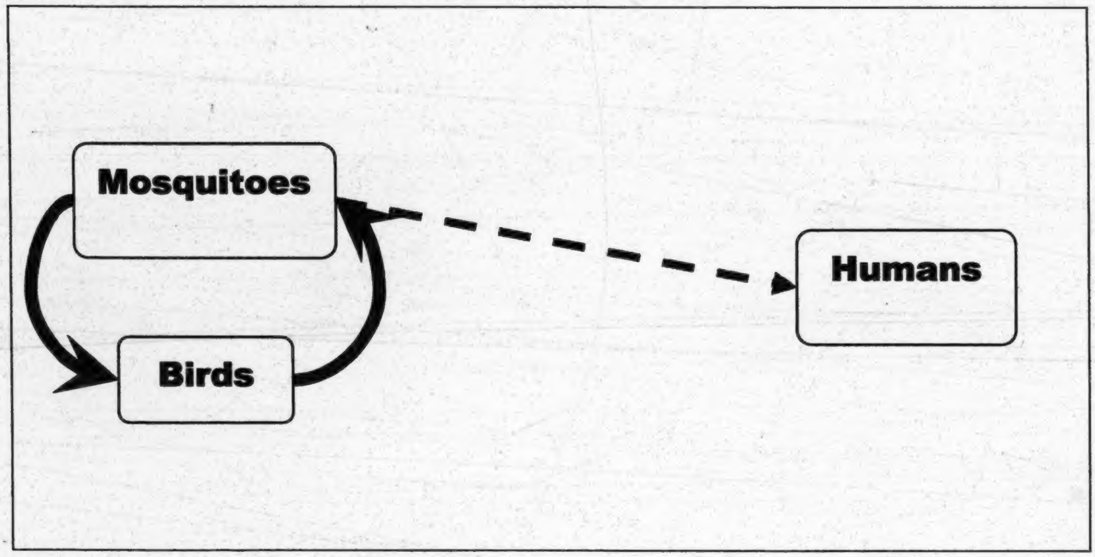

Figure 1: WNV transmission cycle

Once introduced, the virus has the ability to persist from year to year. In Eurasia the usual epidemiologic pattern is one of isolated avian outbreaks, apparently resulting from importation of the active virus by migratory birds into an area with appropriate climatic, vector and amplifying host conditions (Hubalek et al. 1999). Following its introduction in North America, the evident pattern was one of an epizootic with increased avian mortality due to lack of previous exposure and adaptation to the virus (CDC 2002).

Susceptibility to infection varies among bird species. On one end are species characterized by high susceptibility to infection followed by high death rates, and on the other, species which are much less susceptible to both infection and death from the virus. Somewhere in between are species which are susceptible to infection, and which develop significant blood levels of virus but the subsequent mortality is low. The importance of these species in the propagation of virus is still to be determined. Susceptibility to fatal infection with the virus varies markedly for adult and young birds. Juvenile individuals are more likely to experience high death rates compared with adults, which instead will present high incidence of circulating antibodies following exposure to the virus (Rappole et al. 2000).

Mammals and humans, which develop only transient and low-level of virus in their blood (viremia), are not capable of contributing to virus amplification. These species can act as dead end hosts only, following the bite of an infected mosquito (Fig. 1.).

In order to extend the natural cycle of WNV infection to humans the mosquitoes must act as bridge vectors, feeding first on infected birds, and then on humans. Among more than forty species found carrying the virus, *Culex* species are the most important in transmitting the disease to humans. The *Culex* species have their peak feeding during dusk and dawn, thus the risk for infection in humans is higher during these time periods (Campbell et al. 2002). The *Culex tarsalis* mosquito, which breeds primarily in irrigated farmlands, is generally regarded as being responsible for WNV transmission in the western Canadian provinces. Laboratory studies demonstrated it to be one of the most effective vectors in transmitting WNV (Turell et al. 2001). In addition, the over-wintering mechanism, which facilitates virus survival within infected mosquitoes, and is present in many species, including *Culex tarsalis*, may play an important role in the persistence of the virus in North America.

WNV is found in many endemic areas of Africa where it is settled into epizootic cycles, with epidemic peaks when the local population of birds, horses and humans have a low prevalence of antibodies. Higher virus density is observed in areas with large populations of migratory birds localized transversally from Western Africa to Madagascar or vertically from South Africa to Europe and Russia (Murgue et al. 2002).

The distribution of WNV within a region is influenced by complex ecological factors; therefore, making predictions for a potential human epidemic is difficult. In order to assess the potential for an outbreak multiple factors must be considered, including the following:

- human population density

- vector characteristics (abundance of mosquitoes, their feeding patterns, and flight range)
- reservoir characteristics (population density of the avian host reservoir, presence of susceptible hosts)
- virus presence and characteristics (virulence)
- environmental factors (climate-rainfall and temperatures, vegetation, landscape)
- implementation of prevention and control measures (vector control programs , public education)

2.1.2. Human disease

The most likely route of WNV infection to humans is through the bite of an infected mosquito. Other means of transmission have been recently documented, including (CDC-DVBID 2004):

- organ transplantation: rare, but apparently associated with a high risk of encephalitis (over 50%).
- blood transfusion: in one study (Biggerstaff et al. 2003) mean risk was 1.5-12/10,000 donations, but symptoms may develop in over 50% of cases, probably due to the higher infective dose. The evidence for this mode of transmission prompted the implementation of blood screening procedures in both US and Canada.
- from mother to child: trans-placental transmission has been documented, with potential involvement in congenital malformations. Transmission through breastfeeding is also considered possible.
- occupational: several cases of WNV infection associated with occupational exposure have been reported in laboratory workers, turkey-breeding and crocodile farm workers.

Beyond the special circumstances listed above, no human to human transmission has been documented.

Most infected individuals remain asymptomatic. When infection is clinically manifest, it presents most often as West Nile Fever, characterized by flu-like symptoms that last just a few days. Symptoms normally show up 3-15 days after the mosquito bite.
Rarely, more severe WNV neurological syndrome may occur. The neurological spectrum of manifestations includes encephalitis, meningitis, and acute flaccid paralysis (poliomyelitis-like, or Guillan-Barre-like). The West Nile neuroinvasive disease tends to be more severe and more likely to cause hospitalization than uncomplicated fever. It also has an estimated 7-9% case fatality rate (Hayes 2004). In addition to being able to cause severe acute illness, WNV neurological syndrome might result in a prolonged rehabilitation period, especially in older persons (Labowitz et al. 2004).

In an affected population, the proportion of different clinical syndromes depends on previous WNV activity in the area and consequent background immunity, but also the age structure of the population and the existence of surveillance and control efforts. Whether strain related variations in WN viral neurovirulence may also contribute is currently unknown.

In endemic areas, with high prevalence of background immunity, WNV infection is essentially associated with early childhood, and is mostly a self-limited, non-fatal febrile disease, rarely associated with encephalitis.

In contrast, in urban areas of the temperate zones, where little or no previous virus activity has occurred (i.e. North America), aging and immunologically naïve populations are more likely to experience neuroinvasive disease. Serologic surveys indicate that infection rates are similar in every age group, and both sexes are equally susceptible but the frequency and severity of clinical illness increases with age (Tsai et al. 1998; Weinberger et al. 2001; Petersen et al. 2003). About 1 in every 150 infected individuals develops severe neurological disease (Tsai et al. 1998; CDC 2001; Mostashari et al. 2001).

In recent urban epidemics, among the risk factors associated with WN infection were the length of time spent outdoors, and failure to undertake personal protective measures against mosquitoes (Han et al. 1999; Mostashari et al. 2001).

Therapy for WNV, as for all flaviviruses, has been only supportive since at the present time there are no available antiviral or other drugs with proven efficacy. The most promising treatment options, currently under study, include interferon alpha, anti-WNV immunoglobulin, ribavirin, and gene targeted technologies (Power et al. 2004).

A variety of WNV vaccines are currently under study, being assessed in terms of efficacy and effectiveness. A vaccine targeting the elderly and the immuno-compromised, living in areas with high risk has been identified as the appropriate strategy (Gould et al. 2004).

With no specific treatment or vaccine available, primary prevention through public health education campaigns becomes of paramount importance.

2.1.3. WNV distribution and impact in Western Hemisphere

The discovery of WNV in the summer of 1999 in the USA dramatically raised the importance of the epidemiology of arboviruses in the Western hemisphere (Roehrig et al. 2002).The modality of virus introduction to this new territory was not fully elucidated. The subsequent spread of the virus throughout much of the US and Canada between 1999-2004 underlines the ability of arboviruses to become established when introduced in new areas given that efficient vectors, susceptible amplifying hosts and reliable over wintering mechanisms are present (Calisher 2000).The virus caused widespread mortality in some indigenous bird species (CDC 2002).

The emergence of WNV in North America has prompted an immediate public health response. At present, WNV surveillance programs are in place in both US and Canada. Data are being collected on a weekly basis (during the transmission season) and are reported for wild birds, sentinel chicken flocks, veterinary cases, human cases and mosquito pools.

Table 1 illustrates why WNV has been a public health concern since its arrival in Western hemisphere. It has generated large numbers of human cases and considerable numbers of deaths. Since its introduction in Western hemisphere WNV has spread continuously from East to West. In the US, from 1999 to 2001, 149 cases of illness and 18 deaths were reported in humans. In 2002, 4100 cases and more than 280 deaths in humans were detected through surveillance systems. 2003 ended with 9862 cases and 264 human deaths (CDC). During 2004, 2539 cases were reported (CDC 2006). In the US, human infections are normally detected from May to December, with the majority of cases occurring in August.

At the present time, WNV activity is reported in most of the US, from Atlantic to Pacific (Petersen et al. 2003)in Canada (Buck et al. 2003), and more recently in the Caribbean (DuPuis et al. 2003; Estrada-Franco et al. 2003; Komar et al. 2003; Quirin et al. 2004).

In Central America and the Caribbean the epidemiology and further evolution of WNV may be influenced by the opportunity of year round transmission, by the pre-existing immunity to other flaviviruses, and by genetic mutations of the virus (Beasley et al. 2004). Although not many human cases have been reported from the Caribbean, the virus activity has been detected in birds and horses, maintaining the potential for future human infections. This region also serves as wintering ground for migratory birds, therefore it is likely to contribute to the maintenance of the virus in avian reservoirs (Gould et al. 2004).

Table 1: WNV in North America – total human cases/year

Year	USA	Canada
1999 - 2001	**149/** 18 deaths	-
2002	**4,100/** 280 deaths	**315/**20 deaths
2003	**9,862/** 264 deaths	**1,388/**14 deaths
2004	**2,539/**100 deaths	**25/**2 deaths
2005	**2676/** 91 deaths[a]	**225/**12 deaths[b]

a- (CDC 2006); b-(PHAC 2006)

2.1.4. WNV in Canada and Alberta

As a response to WNV emergence in the USA, surveillance for WNV in Canada was first introduced in 2000. It has involved collecting and testing birds and mosquitoes, and enhanced passive surveillance for human and equine cases. Coordination of a multidisciplinary National Steering Committee and working groups, as well as public education initiatives have also been part of the public health response.

WNV was first detected in Canada in August 2001. During that year, 128 dead birds and 11 mosquito pools tested positive in Ontario.

For 2002, 315 confirmed cases of human illness were reported in Ontario and Quebec. WNV activity was also recorded in dead birds only, or in combination with mosquitoes and or horses in Nova Scotia, Quebec, Ontario Manitoba, and Saskatchewan (Buck et al. 2003).

2003 registered the largest numbers of cases in Canada: 1388. In that year WNV activity was reported in 7 provinces: Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan and Alberta. The largest number of human cases was registered in Saskatchewan – 935. In Canada, the season for WNV infections lasts from May to September.

The arrival of WNV in Alberta was associated with the virus detected in birds, mosquitoes, horses and humans. The first infected bird was confirmed on July 9, 2003, and first human case was confirmed on August 12, 2003. In total 435 birds, 31 mosquito pools and 172 horses tested positive. The distribution of WNV was characterized by strong clustering of positive mosquitoes, birds and horses in the parkland and grassland regions of the province.

A total of 272 confirmed clinical cases were reported in Alberta during 2003 season, from which 49 were WN neurological syndrome. The highest incidence of WNV cases was reported in the Palliser Health Region, in the south-eastern part of the province (131 cases). Higher temperatures and lower precipitation, conditions that are known to favour the development of *Culex* mosquitoes, characterize this region.

The clinical presentation of cases in Alberta included both WNV fever and neuroinvasive disease. The neurological manifestations were in general similar to those previously reported in North America. Multiple neurological symptoms occurred in each patient and the neurological presentation was diverse (Sayao et al. 2004). There were no gender differences in WNV infection incidence. No cases were attributed to blood products, organ transplant or vertical transmission.

In 2004, WNV activity was detected in Ontario, Quebec, Manitoba, Saskatchewan and Alberta in mosquito pools and dead birds, but colder than average and more humid summer has resulted in few human cases. A total of 29 human cases (as of Nov 1, 2004) were detected in Ontario, Quebec, Manitoba and Alberta (PHAC 2004). In Alberta two human cases were detected, one travel related and one considered as locally acquired WNV neurological syndrome (AHW 2004).

In 2005, 127 cases were detected throughout Canada; 10 of them were detected in Alberta.

2.1.5. WNV seroprevalence

The prevalence of immunity to WNV depends on geography and the population studied. It is difficult to compare the results from different serosurveys because the approach to estimate seroprevalence may have been different (i.e. study population, detection methods).

At one extreme, serological surveys revealed endemic areas in Africa, with West Nile antibodies reported in more then 60% of population (Taylor et al. 1956).

General background immunity in other regions is much lower. A post-epidemic study of seroprevalence, estimated 2-4% in Bucharest, Romania, in 1996 (Tsai et al. 1998). Other studies have estimated 2.1% in the Czech Republic in 1997 (Hubalek et al. 1999), and 8% in Jordan in 1998 (Batieha et al. 2000).

In the Western Hemisphere, a 3% seroprevalence was estimated in Queens, New York in 1999 (Mostashari et al. 2001), 0-1% in Connecticut in 2000 (Hadler et al. 2001), and 1.9% in Ohio (Mandalakas et al. 2005). A study among blood donors in Colorado (Brown 2004) indicated a 0.2% WN seroprevalence for 2003. Distribution of positives covered most major communities in Colorado, but rural areas were not very well represented.

In Ontario, in an area with highest incidence of WNV cases in 2002, seroprevalence was estimated to be 3.1% (95%CI: 2.2 -4%) (Elliott et al. 2003). A study conducted in Saskatchewan in the spring of 2004 revealed that more people were infected in the Five

Hills Region of the province, than in any other place studied in North America since the appearance of the virus in Western hemisphere (Saskatchewan_Health 2004). 10% of the adults participating in that survey had evidence of infection from the 2003 season. In rural areas, the risk of infection was five times greater than in the city of Moose Jaw. People over 60 were more likely to get infected than the rest of the population.

Following the first year of WNV activity in Alberta (2003), seroprevalence was estimated at 0.3% (95% CI: 0.12-0.58)(Ivan et al. 2005). The highest incidence was found in rural Palliser: 4.56% (95% CI 2.79-6.77).

2.2. Health behaviours and risk perception theories and research

The following sections are intended as a very brief approach to these topics, aiming to underline aspects that are relevant for this study in particular, and public health practice in general.

2.2.1. Attitudes and health related behaviours

2.2.1.1. Attitudes and behaviours

An attitude is defined by psychologists (Wood et al. 1999) as a relatively stable evaluation of a person, object, situation, or issue (i.e. beliefs). Most attitudes appear to consist of three components:

1. a cognitive component, i.e. the thoughts and believes about the attitudinal object
2. an emotional component, i.e. feelings toward the attitudinal object
3. a behavioural component, i.e. how the person is predisposed to act toward the object.

For example, the attitude towards exercise, in an informed individual may consist of:

1. the cognitive component: exercise is good for health, is a good stress reliever, improves appearance;
2. the emotional component: exercise makes me feel great, is fun; and
3. the behavioural component: I exercise every day, I read about exercise, I buy exercise equipment.

Attitudes provide structure for our environment by enabling us to appraise people, objects, situations, and issues; by influencing our social judgement, decisions; and by guiding our behaviours. Attitudes can be acquired through direct experience with people, objects and issues, in which case they tend to be stronger. They can also be acquired vicariously, by adopting them from other people (family, friends), in which case they are less resistant to change (Wood et al. 1999). The media, including advertisers can greatly influence individual's attitudes, being recognized as a power in any modern state.

There is an apparent link between age and attitudes, with older people having more stable attitudes over time than younger people. However, this lack of flexibility seems to result from a limited exposure to change-inducing experiences rather than to the inability or unwillingness to change (Wood et al. 1999).

Social scientists have agreed that people's attitudes lead their behaviour. But studies conducted after 1960 did not found a strong relationship between people's attitudes measured on attitudes measurements scales and their actual behaviour. Attitudes seemed to predict observed behaviour in only about 10% of the time (Wicher quoted by Wood, Wood et al. (1999)). This can be explained by the fact that most often attitude measurement scales are too general. A person may express a strong attitude towards an issue, i.e. environmental protection, but this does not necessarily translate into expected behaviour, i.e. recycling or joining carpools. For attitudes to become good predictors of behaviours, they have to correspond very closely to the behaviour of interest, and this relationship is stronger when the attitudes are strongly held, and readily accessible in memory, and when they vitally affect personal interest (Wood et al. 1999).

The link between attitudes and behaviours is further illustrated by the concept of "cognitive dissonance". This describes "the unpleasant state that occurs when people become aware of inconsistencies between their attitudes or between their attitudes and their behaviour" (Wood et al. 1999). People try to reduce the dissonance by changing their behaviours or their attitudes or finding arguments to dismiss the inconsistency or to reduce its importance (see Box 2.).

Box 2: Example of cognitive dissonance - adapted from Wood et al.(1999)

Smoking:

- Source of cognitive dissonance:
    - Behaviour: I smoke.
    - Attitude: Smoking can kill you.
- Explain away inconsistency
    - I'll quit before it can kill me or I really don't smoke that much.
- Reduce importance of inconsistency:
    - I have good genes. People in my family all lived to a ripe old age. I exercise and have a better diet than most people who smoke. No one in our family has ever had cancer.
- Change behaviour
    - Quit smoking.
- Change attitude
    - Smoking isn't that dangerous.

2.2.1.2. Theories of reasoned action and planned behaviour

Social psychologists Ajzen and Fishbein (1980) developed the theory of reasoned action (TRA). Later Ajzen developed a new theory, theory of planned behaviour (TPB) (Ajzen 1985; Ajzen 1991) by adding a third major construct to TRA. Both theories assume that people are rational and use information to plan their actions. Further, to change a behaviour one must change beliefs about that behaviour; if beliefs change, intentions toward performing an action change also (Ajzen et al. 1980). Development of these theories was influenced by previous work of L.L.Thurston, who developed a method to measure attitudes using an interval scale, of Louis Guttman, who developed a method for measuring beliefs, and of G.W. Allport who emphasized that there is a complex relationship between attitudes and behaviours (Conner et al. 1996).

The main purpose of these theories is to explain and predict human behaviour through motivational influences (attitudes and beliefs), and to further describe strategies for changing behaviour. Both theories are able explain many different behaviours, and can be generalized to many age and ethnic groups of people. They have been used to understand a large variety of health behaviours from physical activity, to substance use, sexual activity, condom use, and other health-related behaviours. TPB shows how attitudes and beliefs influence behaviours; it best applies to behaviours that are, to various degrees, under the volitional control of the person (Conner et al. 1996).

The concepts of TRA are described in Box 3. TPB states that attitude toward a particular behaviour, subjective norms, and perceived behavioural control independently determine a person's intention to perform that behaviour. The influence of each of these independent predictors varies across behaviours and circumstances. Because intentions change over time, it is imperative that the time between intention and behaviour be short (i.e. intention can predict behaviour only if the intention does not change before the behaviour is observed).

Box 3: Concepts of TRA

- *Attitudes* include beliefs about a behaviour, possible outcomes of the behaviour, normative behaviour (of peers), and a motivation to comply with that behaviour.

- *Subjective norm* is a person's perception of importance of behaviour to other people. It is a predictor of intention to perform behaviour and reflects perceived social pressure to do so.

- *Perceived behavioural control* (not found in TRA, but added in TPB) includes person's belief about how much control they have over the behaviour (control beliefs) and how much they believe in their ability to perform the behaviour successfully (perceived power). Perceived behavioural control varies across circumstances and refers to how easy or difficult the person perceives the behaviour to be. Individuals may have a positive attitude toward performing a particular behaviour, but if they perceive that they do not have the power to perform it successfully, it is unlikely that they will have the intent to perform it.

2.2.1.3. Health Belief Model

The Health Belief Model (HBM) has been used in the last decades to explain health behaviour. It was developed in 1974 by Becker (Becker 1974) and Rosenstock (Rosenstock 1974a; Rosenstock 1974b) in an attempt to explain why people were not participating in screening programs aiming to detect or prevent diseases.

At that time social psychology was dominated by two theories on learning: the "stimulus response theory" by Skinner, Watson and Hull and the "cognitive theory" of Kurt Lewin. The former focused on the association between behaviour and the reinforcements or rewards of that behaviour. The cognitive theory, on the other hand, focused on cognitive processes including reasoning, thinking and expecting, and stated that behaviour was related to the subjective value that the person placed on the outcome of the behaviour (the concept of value expectancy).

The purpose behind HBM was to provide a model that can explain a particular health problem and to provide the base for programs aiming to change related health behaviours. HBM is broad in scope, being applicable to nearly all health-related behaviours. It is not limited to any particular age or cultural group. Its main limitations appear to derive from HBM being a cognitive model, and it is therefore not generalizable to infants, very young children, or cognitively impaired persons (Sheeran et al. 1996).

HBM is particularly useful for public health. The emphasis of the model on avoiding negative outcomes, as will be detailed later, makes it useful to primary prevention strategies (e.g. immunizations), secondary prevention (e.g. screening) and tertiary prevention strategies (i.e. minimizing long-term adverse conditions associated with a disease).

HBM assumes that an individual's perception of the environment would determine that person's actions. The main concepts included in the model can be grouped in three categories: individual perceptions, modifying factors, and likelihood of action (Box 4).

Box 4: Concepts of HBM

Individual perceptions including:

- perceived susceptibility: one's beliefs about susceptibility to a particular health condition and
- perceived seriousness: one's beliefs about how serious that condition might be.

The modifying factors such as:

- demographic variables as age, gender, race, ethnicity
- psychosocial variables of personality, social class status, reference group pressure
- structural variables such as knowledge of the disease and prior experience with the disease
- perceived threat of disease.
- cues to action (internal or external pressures that trigger a response) like mass media campaigns, advice or encouragement from other people, illness of a peer or family member, newspaper article, reminder postcard from physician, etc.

Likelihood of action -likelihood of taking recommended preventive health action which results from perceived benefits minus perceived barriers of taking action

The model hypothesizes that health behaviour or action depend on three interacting factors: concern about health, belief in vulnerability or susceptibility, and the belief that engaging in the health behaviour would benefit the person, would reduce the risk of disease, and could be done at a reasonable cost. The likelihood of action results from the person's perceived benefits minus the perceived barriers to taking action. Perceived benefits reflect knowledge and beliefs about how a particular behaviour may modify the susceptibility or seriousness of a health condition or disease. Perceived barriers, often experienced simultaneously with the benefits include perceptions that the behaviour or action will be inconvenient, unpleasant or expensive.

The initial HBM was further expanded include the concept of self-efficacy (the belief in one's capability to perform an action). The HBM included among its concepts risk perception (perceived threat of disease) and acknowledged its influence on health behaviours, within a complex context of other modifying factors (e.g. demographics, knowledge, and social values).

Several studies provided support for this model. Hochbaum (1958) in his study on why people did not participate in public X-ray screening for tuberculosis (TB), found that the decision to get an X-ray depended on person's belief that they might contract TB, that they could have the disease without experiencing relevant symptoms, and that they might benefit from early diagnosis. Posters and radio announcements provided cues for action for many people, especially for those having all the above beliefs. Even those less convinced were determined to show up for the screening. In contrast, individuals who were very convinced but who had a fear of finding out that they have the disease did not participate in the screening.

Rosenstock (1974c) brought moderate support to the model through a review of studies in which a particular action was found to depend on the interaction between one's perceived susceptibility and perceived benefits.

Janz and Becker (1984) conducted a critical review of 46 studies based on HBM. Their findings provided considerable empirical support for the model, with similar findings from both prospective and retrospective studies. They computed a significance ratio by dividing the number of statistically significant findings by the number of studies reporting significance for that dimension of the HBM.

2.2.1.4. Changing behaviours

Persuasion is a deliberate attempt to influence the attitudes and or the behaviours of other persons. Psychological research has identified four elements in persuasion (Wood et al. 1999):

- the source of persuasion (who is doing the persuasion)
- the audience (who is being persuaded)
- the message (what is being said)
- the medium (the means by which the message is transmitted).

Credibility, attractiveness and likeability are factors that can positively influence the persuasive ability of the source. Expertise and trustworthiness make a communicator credible. The influence is even greater when the communicator's credentials are known beforehand. The audience tend to attach more credibility to sources that have nothing to gain from persuading or even better, if they seem to be arguing against their best interest.

In general, audiences with a lower intelligence are easier to persuade. A one sided message (in which only one side of a message is given) is more persuasive if the audience in not well-informed about the issue, is not particularly intelligent, or is already in agreement with the point of view. A two-sided approach (in which both sides of an issue are mentioned) seems to work best when the audience is well- informed, fairly intelligent, or initially opposed to the point of view (Wood et al. 1999).

The two-sided approach usually attracts more people than a one-sided appeal.
The message can be well-reasoned, logical, and unemotional ("just the facts"), or it can be strictly emotional ("scare the hell out of them"), or it can be a combination of the two. There are a number of persuasive message strategies that can be used, one of them involving the use of fear to promote better health. Fear appeals are persuavive messages that highlight the harmful physical or social consequences of failing to comply with message recommendations. Arousing fear seems to be effective for persuading people to adopt healthier attitudes and behaviours (Robberson et al. 1988). In relation to various

issues like smoking, seat-belt use, or regular chest X-rays, high-fear appeals were more effective than low fear appeals (Higbee 1969). Moreover, fear appeals were most effective when the presentation outlined definite actions the audience can take to avoid the feared outcome. Fear appeals have enormous persuasive potential, but their effectiveness depends on the structure of the message. It is considered that an effective fear appeal must include a severe threat, evidence suggesting the vulnerability of the target, and solutions that are both easy to perform and effective (Hale et al. 1995).

Last but not least, repetition is an important factor in persuasion. Advertisers who repeat their message over and over again exemplify this best.

Knowledge is the starting point for behaviour change, a necessary, but not sufficient condition. From a social cognitive perspective on health, individual behaviour change can be induced by modifying people's personal factors (knowledge, skills, self efficacy, outcome expectations, and personal goals) and by altering environmental factors (social, institutional, physical). Further, the behaviour change is a complex and multistage process in which, beside knowledge, other internal social cognitive factors and environmental factors must be considered (Maibach et al. 1995).

2.2.1.5. Relevance for public health

Public health interventions often aim at behaviour change, in order to reduce actions that induce or contribute to occurrence of disease. In this context the relationship between attitudes and behaviours should be acknowledged in designing such interventions. It should be also noted that persuasion can be more effective in inducing behaviour change at an individual level (e.g. in a clinician - patient relationship), while when the message is for the larger public, changing attitudes is a more realistic objective; a sustainable change in behaviours is much more difficult to attain for populations.

2.2.2. Risk perception

2.2.2.1. Definitions of risk

Although an extensive literature exists on the topic of risk, there is a relatively little consensus over the definition of risk.

On one side are those who define risk, as an objective property of an event or activity, and measured as the probability of a usually well-defined, adverse event. The most widely used definitions of risk, derived from modern positivism describe risk as being the probability of an event with negative consequences within a time frame.

On the other side is the constructivist paradigm that generates critiques to the above definitions. The harshest criticism has come from a strong form of subjectivism within the constructivist paradigm that is entirely opposed to the notion of objective risk. This strong form, a relativistic view of social constructivism derived from a phenomenological philosophy, views risk as nothing more than subjective perceptions shaped by the filters of culture and social structure (Rosa 2003).
Individual understanding of risk is largely intuitive. How closely any individual comes to the extremes is shaped by their world views (as described in the next section).

Some consider that the objectivist and subjectivist views may tend to be extreme and taken separately, are poor descriptions of the reality, and therefore propose alternate definitions, as for example: “Risk is a situation or an event where something of human value (including humans themselves) is at stake and where the outcome is uncertain.” (Rosa 2003).

At the foundation of this particular definition is the notion that certain states of the world, which are possible and not predetermined, can objectively be defined as risk. The fact that these states are not predetermined means that they are probabilistic and therefore, embedded with some degree of uncertainty, leading to inherent unpredictability.

2.2.2.2. Public perception of risk

Despite divergences on defining risk, more consensus exists in considering the public perception of risk as an important topic. It does influence the priorities for regulatory bodies and further allocation of financial resources, sometimes to the distress of technical experts arguing that other hazards deserve higher priorities (Slovic 2000). Within this dispute, the public perception of risk has often been seen as irrational, subjective, emotional and foolish. In contrast, experts view themselves as objective, rational, and consider their assessments of risk as providing the "real" risks (Slovic 2000).

Substantial research has proved that many of the lay public's reaction to risk cannot be blamed on irrationality or ignorance (Slovic 2000). Further, social science analysis tends to challenge an extreme objective approach highlighting that hazards are objective, but risk perception associated with them has an inherent subjective nature. In this view, risk does not exist out there, independent of our minds and culture, but rather humans have invented the concept of risk as a mean of understanding and coping with uncertainties and dangers. Even the probability risk estimates of an expert are based on theoretical models whose structure is ultimately subjective and assumption-laden; judgement is used in all stages of the process from the initial structuring of a risk problem to deciding which end points (or consequences) to consider in the analysis. Judgements inherently introduce subjectivity (Slovic 2000).

For example, agreeing on which measure to use when performing a risk assessment (i.e. to measure fatality risk by deaths per million people in a population, or loss of life expectancy associated with an exposure) can influence how risk is further perceived and evaluated. Different ways of summarizing death reflect different sets of values, and involves value judgements. Numerous studies have shown that different ways of presenting the same risk information can lead to different evaluations and decisions. For example, a change in opinions can result from presenting the information about consequences in terms of either life saved or lives lost, mortality rates, versus survival rates (Slovic 2000).

The lay public risk assessments are different from the scientists' models. The fact that they are different from scientists' models is not a valid argument to declare them irrational. Public's assessments of risk are based on assumptions and subjective assessment techniques (intuitive risk assessments). Research has further shown that the public has a broad conception of risk, qualitative and complex, that incorporates considerations such as uncertainty, dread, catastrophic potential, controllability, equity, risk to future generations, into the risk equation (Slovic 2000).

Experts' perceptions of risk, on the other hand, are not closely related to the above-mentioned dimensions or the characteristics that underlie them. Instead they tend to see riskiness as being associated with expected mortality. Of course, even a prediction of expected mortality will be conditioned on a number of assumptions and model choices that cannot be defended as strictly objective.

Many conflicts over risk may result from experts and laypeople having different understandings of the concept. Mere presentation of risk statistics by experts often does little to change people's attitudes and perceptions. There are legitimate, value-laden issues underlying the multiple dimensions of public risk perception, and they need to be considered in risk policy decisions. Public perception of risk is a multidimensional concept which needs to be understood and taken into consideration. This is particularly relevant in situations where risk communication is necessary.

Another explanation for public's disagreement with scientists' risk assessments is lack of trust. The limited impact of risk communication efforts in some instances can be attributed to the lack of trust. Lack of trust is itself a wide subject within the field of risk research, but further development of this topic is beyond the scope of the present research project.

Social amplification of risk

A group of researchers (Kasperson et al. 2003) introduced the social amplification of risk framework (SARF) in an attempt to develop an integrated theoretical framework capable of accounting for findings from studies belonging to a wide range of research domains (media research, psychometric and cultural schools of risk perception and organizational responses to risk). The framework is intended to describe the dynamics of various social processes underlying risk perception and response. More precisely, the framework addresses those processes by which certain hazards and events that experts assess as relatively low in risk can become a particular focus of concern followed by socio-political activities within a society (risk amplification), while other hazards that experts judge more serious receive comparatively less attention from society (risk attenuation).

Several examples of hazards that were subject to attenuation include: naturally occurring radon gas, automobile accidents or smoking. Examples of issues that have been subject to social amplification of risk perception are incidents like Bhopal (India), and Chernobyl (Ukraine); BSE (the "mad cow" disease); and genetically modified food.

The basic assumption is that "risk events" (both actual and hypothesized accidents and incidents), may remain irrelevant or have a limited impact unless people observe and communicate them to others. SARF describe this often complex communication process through concepts as risk, risk events, risk signals (images, signs, and symbols), and interacting factors (a wide range of psychological, social, institutional, or cultural processes) that intensifies or attenuate perceptions of risk. The experience of risk therefore is not only an experience of physical harm, but also an expression of the way in which groups and individuals learn to interpret risk. Within this framework, risk experience can be properly assessed only through the interaction among the physical harm attached to a risk event and the social and cultural processes that shape interpretations of that event, secondary and tertiary consequences that emerge, and the actions taken by managers and publics.

It is also important to mention the role that media appear to have in shaping public perception of risk. Studies of mass media coverage in the US (Kasperson et al. 2003) showed that homicides, accidents, and some natural disasters tend to receive heavy coverage, while death from diseases, for example, receives only light coverage. These patterns of coverage further correlated with lay public judgements of the frequency of these causes of death. The massive coverage of an event influences public perceptions of the seriousness of the event as well as the political agenda of institutions and social groups. In general , mainstream news media are attracted by individual stories, major disasters, official reactions that appear in the present while they are ill-equipped to maintain attention to any particular future threat (Kasperson et al. 2003). In other words, the news media are better at reporting risk retrospectively than prospectively. More research is needed though to fully explain the relationship between mass-media coverage and the formation of opinion concerning risk.

2.2.2.3. Risk perception and affect

Research has revealed that the affect (defined in psychology as emotion or desire as influencing behaviour) is directly involved in fundamental psychological processes such as attention, memory and information processing. Affective reactions are often the very first reactions occurring without extensive perceptual and cognitive encoding and subsequently guiding information processing and judgement. Or in other words all perceptions may contain some affect.

In the area of individual risk perception, an inverse relationship has been observed by numerous studies (Slovic 2000). In general, a higher perceived benefit is associated with a lower perceived risk; and a lower perceived benefit is associated with a higher perceived risk. This inverse correlation between perceived risks and perceived benefits is linked to the individual general affective evaluation of a hazard. If an activity or technology is liked (e.g. automobiles), people tend to judge its benefits as high and its risks as low. If the technology or activity is disliked (e.g. pesticides), the judgement is opposite (Slovic 2000).

It thus appears that the affective response is primary and the risk and benefit judgements are derived. The images that people evoke when asked to think about an individual technology can be both positive and negative. The affective values of these positive and negative images appear to sum in a way that is predictive of our attitudes, perceptions and behaviours. If the balance is positive we respond favourably (Slovic 2000).

A constant in risk perception studies is the negative imagery associated with the word "chemicals" and their further assessment as high risk (Slovic 2000). Several examples are provided in Box 5 below:

Box 5: Negative image of "chemicals" – adapted from Slovic (2000)

In a Swedish survey in 1988, three non-drug chemicals: cigarette smoking, pesticides and alcohol, scored the highest perceived risks. Perceived risks and benefits were not positively correlated.

Several surveys in US and Europe have shown that associations to the word 'chemicals' are dominated by negative imagery (death, toxic, dangerous). The only exception is the class of prescription drugs, in which case responses are more neutral or positive. Therefore there is a strong differentiation in the perceived trend in risk between prescription drugs and other chemicals.

Slovic considers that risk perception, acceptance of risk and further trust in risk management are based on knowledge and experience, but coloured by affect as well as worldviews. Worldviews are general social, cultural and political attitudes that appear to have an influence over people's judgement about complex issues (e.g. fatalism, hierarchy, individualism, egalitarianism, technological enthusiasm). Another interesting finding is that affect and worldviews seem to influence the risk-related judgements of laypeople as well as scientists.

In the light of the complex relationship between risk perception and psychological, social and political factors, the disagreement in evaluation of risk between public and scientists can be better understood. Members of the public and experts can disagree about risk because they define risk differently; have different worldviews, different affective experiences and reactions or different social status.

2.2.2.4. The gender difference in risk perception

Risk perception studies have constantly identified a gender difference in risk perception, with women reporting higher level of concern (Slovic 2000). Many explanations are available, but the topic is still open. In a review of studies addressing this topic, Hitchcock (2001) has explored the extent of these differences.

Firstly it should be mentioned that there is a considerable diversity in the way risk is assessed and reported. Studies may report subjects' ratings or rankings of diverse hazards for example in the form of "concern", "worry", "intent to take action", "dread of hazards". Therefore studies adopt different conceptualizations of risk perception that overlap in various degrees with other evaluative or affective processes (Hitchcock 2001).

One perspective brings together studies that found that differences in risk perception are not found solely by gender, but rather with gender interacting with other demographic factors like race, nationality, socioeconomic status (Hitchcock 2001). In this context researchers have identified the "low-risk perception white males' who tend to be better educated, be more affluent and politically conservative, with a trust in institution and authority and with anti-egalitarian views (Slovic 2000). White females by comparison, tend to see the world more as a danger as they benefit less from technologies and institutions. It is interesting that, for example, studies conducted in the U.S. found that black males tend to report a level of risk comparable to white females (Hitchcock 2001). Gender differences may also vary among cultures, and also there seems to be influenced by material resources and social class, with a greater worry being reported by those from economically distressed countries or social groups.

Another hypothesis stating that gender difference in response to risk information resides solely on difference in knowledge between male and female was not supported by study findings (Hitchcock 2001). For example the gender difference is not manifested among lay people only but among professional scientists as well (Slovic 2000).

An alternate explanation is based in differences in social roles between male and females with females expressing more nurturing behaviours. Health and safety are more salient to woman and implicitly are reflected in higher level of concern for a given level of risk (Hitchcock 2001).

Psychological research has further supported the idea that gender differences do not reside on the level of cognitive appraisal of risk, but rather on a more complex process of behaviourally and emotionally responding to certain information. Women are more likely to aim to reduce risk and to underrate their ability to do so. Men are more likely to see a hazard as a challenge and to overestimate their ability to overcome that challenge (Hitchcock 2001).

Last, but not least it has been suggested that in studies of self reported attitudes there is a response bias at play because it is more socially acceptable for women to express their concerns (Hitchcock 2001).

Another relevant aspect from the area of perception of risks to health is the unrealistic optimism concept, explicitly that we tend to believe that our own health risks are lower than those of others, and that we believe we are less likely to become ill or die if exposed to the same factors (Hitchcock 2001). This has a direct implication for any behaviour change intervention.

2.2.2.5. Relevance for public health

Public health action often includes communication of health related risks to the public, and aims to influence public attitudes and behaviours towards reducing the risk associated with health events. Therefore documenting the public perception of health related issues is paramount for effective communication. Perceptions of risk are in a constant flux, therefore interventions and decision-making can be adequately informed by periodical surveys of public risk perceptions.

The impact of media on public risk perception should be understood and continuously assessed. Media tends to rather capture an adverse event that has already occurred (i.e. an epidemic) rather than to inform on future hazards (i.e. what negative consequences may result from lack of public health control measures, or at individual level, lack of healthy behaviours). A good understanding is the first step for a good collaboration. Public health officials should maintain media's interest in health issues in order to use it as an effective channel for public health messaging.

2.3. WNV public perception and behaviours in North America

Since its introduction in North America, WNV has prompted public health surveillance and control efforts. As part of this trend, a series of surveys were conducted in order to document risk perception, behaviours, attitudes and risk factors associated with WNV infection in humans. This chapter summarises the findings of WNV surveys conducted to date in North America.

I limited the literature review to surveys conducted in North America. Surveys conducted in Europe and Israel were very few, were not population based, and were different in aims and content of the survey instrument. I consider that North American surveys are more similar in the content of the survey instrument and targeted populations that are more similar culturally.

2.3.1. U.S. studies

A seroepidemiological survey conducted in New York in 1999 shortly after the epidemic peak (Mostashari et al. 2001) revealed that, although 84% of respondents named one or more personal protective measure against WNV, 39% had not taken any of these measures. Only 9% of respondents consistently used repellent. The highest seroprevalence was found among individuals who were outdoors for more than two hours following dusk or before dawn. The study results underlined the considerable disparity between awareness and behaviour emphasizing the need for more effective public health educational efforts.

The study conducted in Connecticut in 1999 and 2000 (McCarthy et al. 2001) estimated household characteristics, behaviours and attitudes associated with WNV infection. While 58% claimed to be a little or very worried about contracting WNV, 48% were a little or very worried about getting sick from mosquito-control programs using pesticides; 79% practiced one or more personal precautions to avoid exposure; and 86% of households practiced one or more mosquito-source reduction activities. Practicing two or more personal precautions was associated with a higher perceived risk of infection and being female. Exercising two or more larvae source control measures was associated with households speaking English as the first language. Differences were found in individual protection measures between cultural groups and age groups.

The Harvard School of Public Health, in a study of public perceptions of WNV (Blendon et al. 2002), reported that among respondents living in a self-described 'high-mosquito' area, 33% felt that it was 'very / somewhat likely' that they or a relative would contract WNV in the next 12 months. A considerable proportion of respondents (43%) claimed to take no precautions against mosquito bites. In those "high-mosquito"areas, where spraying has occurred against mosquitoes to prevent the spread of the West Nile virus, 91% of respondents approved of the spraying. Nationwide, 77% of Americans reported to favour spraying as a method of preventing the spread of West Nile virus, if it appeared in their area. The study also measured public knowledge of WNV health impacts (e.g., associated mortality rates) and treatment of WNV, finding limited knowledge. Also, 13% of study participants reported to have consulted with their veterinarians regarding the potential WNV associated health risks for their pets.

The survey was repeated in the following years (2003 and 2004) bringing new data and pointing out trends in WNV attitudes and behaviours. The 2004 survey (HSPH 2005) showed that people who see themselves as living in high mosquito areas are twice as likely to take precautions against mosquito bites. This is relevant as many of the cases in 2004 were found in areas identified by residents as low mosquito areas. The consequent studies showed that there is a consistent level of concern nationwide despite a shift in foci of WNV activity, and that there is a small trend toward increased personal protection. Important regional and demographic differences remain and there is still a considerable need to educate the public about repellents.

A study conducted in 2002 by the Connecticut Department of Public Health assessed knowledge, attitudes, and behaviours related to WNV. A high degree of knowledge of

WNV was documented as well as awareness of the susceptibility of the elderly to developing severe illness due to infection. Use of at least one personal protection barrier was more likely in persons over 50 years than in younger persons. Respondents with confirmed WNV infection were less likely than other respondents to report using some form of personal protection. Surprisingly, local WNV surveillance awareness among the public was poor, and belief in the presence of WNV in the vicinity was not an established predictor for the use of personal protection barriers (CDC 2003).

Aiming to evaluate a WNV prevention campaign during 2003, a survey conducted in Kansas (Averett et al. 2005) found a discrepancy between knowledge, awareness and behaviour. Almost all respondents (97%) had heard about WNV, 94% knew that it was transmitted through mosquitoes and 70% knew that elderly are most likely to become severely ill. Awareness was reduced among Spanish speaking respondents, compared with English speaking respondents. The majority of respondents (89%) knew one or more protective measure. Most mentioned protective behaviours were avoiding mosquitoes, and use of repellent. Reported behaviour did not reflect knowledge, only a fraction of respondents who knew that use of repellent was a preventive measure, also reporting that they had actually practiced it. The Kansas study also enquired about barriers in engaging in preventive behaviours. More than one third were concerned about the use of DEET due to perceived health risks, while 26% considered that wearing long clothing was uncomfortable. In terms of perceived risk of acquiring WNV, 55% considered the risk to be low, while only 8% considered it to be high. Most mentioned sources of information about WNV were mass media and word–of–mouth; magazines, web sites, brochures and health care providers were mentioned by only a few of respondents. Authors conclude that knowledge and awareness are insufficient to impact behaviour, and that risk perception appears as a moderating factor.

2.3.2. Canadian studies

In a telephone survey conducted in Ottawa area in July 2002 (Wilson et al. 2005), most respondents (72%) reported that they had heard about WNV, and 58% considered it as an important health issue. Mosquito repellent was the most common personal protective measure (reported by 72%). Most had used DEET products (76%). Age was a statistically significant predictor of repellent use, with respondents aged less than 51 years more likely to use repellent than older respondents. The same age group was also more likely to use at least one personal protective measure. The study concluded that there is need for more public education especially targeted at older and urban residents.

A study conducted in Oakville, Ontario in the spring of 2003 (Elliott et al. 2003) indicates that virtually all respondents were aware of the West Nile virus and that most (73%) obtained their information about WNV from news media (TV, radio, newspapers). When asked about the importance of WNV topic, 80% reported that WNV was 'important' or 'very important' issue for Halton Region and 72% felt it was a 'somewhat important' or 'very important' issue for Ontario. While 78% of respondents were 'somewhat worried' or 'very worried' about becoming sick with WNV, 59% were very or somewhat worried about becoming sick from the pesticides used to kill mosquitoes. When asked what worries them more, 56% reported that they were more worried about getting sick from WNV, 22% were more worried about pesticide use and 18% were worried about both. In terms of responding to the threat of WNV in 2003, over two-thirds (67%) would agree to the use of pesticides in order to reduce the number of mosquitoes. Turning to risk behaviours, two-thirds of survey respondents lived on properties that had containers that held water during the summer of 2002. Further, 25% of respondents reported tears in screens that covered doors or windows that opened to the outside.

Nearly two thirds of respondents (65%) rarely or never wore insect repellent when outdoors for 30 minutes or more. Half of respondents rarely or never wore long sleeved shirts and/or long pants. When asked what else they did to avoid being bitten, over half (51%) reported they did nothing. Yet, four-fifths of respondents remember receiving information in the summer of 2002 about how to avoid mosquito bites. While most area residents were aware of the risk of WNV infection as well as public health information about how to reduce the risk, area residents do not appear to have undertaken preventive measures as often as they could.

A survey conducted in Hamilton area in July 2003 (Health_Canada 2003) among English reading parents attending area's family practices, revealed that all survey participants had heard about WNV, and over 90% were reportedly planning or taking precautions and only a few objected to the city's use of larvicides. A substantial proportion of parents expressed serious safety concern about WNV (16%) and was severely restricting their children's outdoor activities because of it. About half had concerns about using DEET products on their children.

In British Columbia, where WNV arrival had been expected in 2003, a public health information campaign was followed by a telephone survey (Aquino et al. 2004). In this study, most respondents reported that information about WNV influenced them to engage in protective behaviours and the odds that these behaviours were practiced more frequently were influenced by the sources of information and behaviours of relatives. The most prominent barrier for engaging in protective behaviours was perception that DEET is a health and environmental hazard. A deficit was also observed in knowledge related to the increased risk for severe WNV manifested by those of older age. More than half of those unaware of this increased risk were from the age group 50 years or older.

2.3.3. Conclusions

Due to increased media attention and information campaigns, there is, according to a number of surveys conducted, good knowledge in the North American general population about WNV, and about the steps to be taken to limit exposure to infection.

A consistent level of concern about WNV is present, but this does not necessarily translate into the consistent practice of preventive behaviours.

Important regional and demographic differences remain in WNV attitudes and behaviours.

The majority of respondents support the implementation of mosquito control programs in their area. Disagreement with these control programs is related to concerns about the safety of pesticides.

Passive sources of information (broadcast media) are the most effective tools for public health messages.

There is need for continuous public education, especially concerning repellents.

Education efforts should target populations at risk (seniors).

3. WNV PUBLIC PERCEPTION AND BEHAVIOURS IN ALBERTA

In the spring of 2004, AHW conducted a sero-survey, as part of an enhanced surveillance initiative. The study aimed to estimate WNV seroprevalence in Alberta, after the first year of virus activity in the province, and also to assess WNV related knowledge, attitudes and behaviours among Albertans. This study represents the largest assessment of WNV in Canada to date (Ivan et al. 2005).

This section summarizes the results of the AHW study.

Almost all respondents (99.3%±0.3) had heard about WNV prior to the survey. More than 90% (90.2 ±0.01) were aware that WNV has been identified in mosquitoes in Alberta. In Palliser region the percentage was 97% (97 ±0.05) and for the rest of the province 90% (90±1). There were no differences between urban and rural areas.

Over 80% (80.5 ±1.3) of respondents were aware that WNV had been identified in people in Alberta during 2003 season. In Palliser the percentage was 95% (95 ±0.7) while in the rest of province the proportion was lower at 80% (80 ±1.3). There were no differences between urban and rural areas.

There was good knowledge about the principal mode of transmission for the WNV infection (mosquitoes). While almost all respondents correctly recognized mosquito bites as a mode of transmission, a considerable proportion of respondents did not know or did not recognize other possible modes of WNV transmission: organ transplant and blood transfusion. More than half of the respondents incorrectly considered that contact with dead birds could be responsible for WNV transmission to humans.

75.3% (75.3±1.3) of respondents recognized that seniors (65 and over) are more likely to develop severe complications when infected with WNV. A considerable proportion of seniors was not aware that their own age group is at increased risk for severe complications of WNV infection; among respondents within the age group 65 and over, only 60% (60±4.2) were aware that their age group is at increased risk. Therefore focused education campaign for groups at risk may be needed. 43.4% (43.4±1.5) of respondents incorrectly considered that young children are also more likely to develop severe complications.

TV was mentioned as first source of information by 48.6% (48.6 ±1.3) of respondents, while newspaper by 30.8% (30.8 ±1.3). Among other sources mentioned were: workplace, magazines, veterinarians, and someone who had WNV infection. The first mentioned as most reliable source of information was TV, by 44% (44 ±1.3) of the respondents, followed again by newspapers 29.5% (29.5 ±1.3) and radio 6.7% (6.7 ±0.7). Overall, over 27% (27.8 ±1.2) of respondents mentioned the radio as one of the most reliable source of information. The percentage was 33.6 (33.6 ±1.8) for rural areas, and 25.4 (25.4 ±1.6) for urban areas.

While in Palliser region 22% (21.9 ±1.2) of respondents mentioned friends as a source of information, in the rest of the province the proportion of respondents was only 12.5%(12.5 ±0.9). No differences were observed between urban and rural areas.

While a large proportion of the respondents mentioned TV, radio and newspaper, a much lower proportion of the respondents mentioned pamphlets, doctors and the internet as sources of information about WNV. The majority of respondents thus relied on passive sources of information (TV, radio, newspaper) as opposed to active sources (internet, doctors.) Passive sources of information (broadcast media) appear to be the most effective tools for public health messaging.

In Alberta, mosquito control interventions initiated by communities may include draining standing water, and the use of larvicides. Almost 82% (81.5±1.1) of survey respondents agreed with the use of these control measures aiming to reduce the number of mosquitoes. The most mentioned reasons for not agreeing with the above control measures were environmental protection (7.9%±0.7), unsafe/hazardous chemicals (6.2%±0.7) and not having enough information about the risk associated with mosquito control measures (5.1%±0.6).

In the Palliser region 67% (67 ±1.2) of respondents were very or a little worried, while in the rest of the province the percentage was only 48.6% (48.6±1.5). No differences were found between urban and rural strata. 41.3% (41.3 ±2.5) of male respondents were very or a little worried about getting the disease, while among female respondents the proportion increased to 57.6 % (57.6 ±1.5).

The majority of respondents rarely or never restricted their outdoor activities. About half of them rarely or never avoided places where mosquitoes were a problem or the times when mosquitoes were most active, during their outdoors activities.
17.1% (17.1±0.9) of respondents rarely wear mosquito repellent while 18% (18±1.1) never did. Most mentioned reasons for not using repellent were: did not bother (6.3%±0.7), concerned about the use of chemicals (4.5%±0.6), and did not see mosquitoes (4.6%±0.6). Other reasons mentioned were allergy, perceived low risk of getting WNV, too much trouble, and the unpleasant smell of the repellents. None of the respondents were concerned over interaction with sunscreen.

Respondents were more likely to engage in personal protective measures in general, if they were worried about getting WNV, and if they spent more time outdoors during risk hours for WNV transmission. Females were more likely to engage in protective measures compared to males.

When asked if the repellent used contained DEET, 74.3% (73.4±1.4) answered yes, 7.1% (7.1±0.9) no and 18.6% (18.6±1.3) that they did not know. Some of the reasons for not choosing a repellent containing DEET were: concerned with the use of chemicals, allergy and cost. Respondents were more likely to use mosquito repellent containing DEET if they were more knowledgeable about WNV and they were worried about getting WNV.

Over 86% (86±0.1) of respondents were aware that they still need to use personal protective measures when a mosquito reduction program is in place in their community.

Respondents were more likely to engage in environmental risk reduction activities if they lived in rural areas, if they were worried about getting WNV and if they were of older age. Most mentioned environmental risk reduction activity was emptying and replacing pools of standing water regularly (44.2%).

Respondents who provided a blood sample were more likely to be WNV seropositive if living in Palliser region as compared to rest of the province and even more likely if living in rural Palliser. Data shows that there is a tendency that those reporting that they always used mosquito repellent containing DEET were less likely to be seropositive, although this association did not reach statistical significance.

4. METHODS

4.1. The theoretical framework

Based on the literature review of health related attitudes and behaviours a simple model was adopted as theoretical framework for the study (Figure 2).

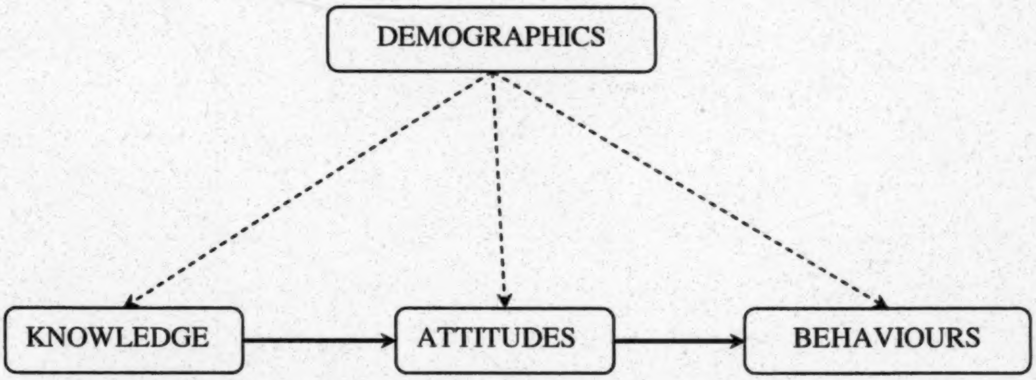

Figure 2: Theoretical model proposed a priori to explain results

Knowledge includes knowledge about WNV, how it is transmitted to humans, who is at risk of developing severe disease, what are the preventive measures recommended to reduce risk of infection, and awareness that WNV has been detected in Alberta.

Attitudes include health-related general and particular beliefs: WNV related risk perception (worried about getting WNV), agreement with mosquito control measures, and self perceived health status (a general subjective appraisal of one's health).

Behaviours refer to personal preventive behaviours, environmental risk reduction activities and participation in a WNV related public health survey.

I hypothesized that knowledge influence attitudes, and attitudes further influence behaviours. I further hypothesized that an association exists between general attitude towards one's health (self perceived health status) and WNV related attitudes (being worried, agreement with mosquito control measures) and explored the nature of this relationship. Finally, I intended to explore the impact of attitudes on adherence with recommended personal protective behaviours. I also expect that demographic variables will be responsible for differences in knowledge, as well as attitudes and behaviours.

4.2. Study methods

A) Review of relevant literature in order to understand current knowledge in the area of risk perception, behaviours and attitudes related to West Nile virus.

An overview of the relevant literature has been presented in Chapter 2.

B) Secondary analysis of data from the Alberta Health and Wellness West Nile Virus Seroprevalence Survey in order to gain in-depth understanding of WNV related behaviours and attitudes among Albertans.

The study data and the analytical approach follow.

4.2.1. The study data

The AHW survey was a cross-sectional prevalence survey that was conducted in two phase (Ivan et al. 2005).

In the first phase, consenting participants answered a telephone survey assessing knowledge of, attitudes toward and behaviours because of WNV.

In the second phase, a requisition was mailed and participants were asked to donate a blood sample at participating laboratories across the province. It should be mentioned that participants were not interviewed in the first place unless they agreed to participate in the both phases of the study. In the end, not all respondents agreeing to participate in the survey followed through with submission of a blood sample for the second phase of the study.

Individuals residing in Alberta since July 2003, who were 18 years and older, and cognitively and linguistically competent were eligible to participate. Random digit dialling was used for the telephone survey, with selected telephone numbers being called a minimum of nine times during different time slots (weekday, evening and weekend) before they were abandoned. A complex sampling design was used including over-sampling from the Palliser Health Region, and non-urban residents. Fifty percent of the sample was allocated to Palliser Health Region, and the remaining fifty percent to the rest of the province. Further, 60% of the Palliser sample, and 55.33% of the rest of the province sample was allocated to urban strata.

The blood samples collected in the second phase were analyzed for WNV IgG antibodies. The results were further used to provide estimates of the WNV seroprevalence in Alberta following the 2003 season.

The survey questionnaire covered the following domains: sources of information, awareness and knowledge, attitudes and behaviours related to WNV. It included questions adapted from previous studies conducted in Canada and the U.S and it contained primarily close-ended questions.

The AHW studies contain telephone interview results from 3780 Albertans. From these 2518 have also participated in the second phase of the study (donated a blood sample).

4.2.2. Data analysis

This section describes the concepts and variables from the survey instrument which are relevant to answering the research questions of the present study, including descriptions of variable coding, as well as weighting, bootstrapping and statistical testing conducted.

4.2.2.1 Variables

Attitudes

Self perceived health status was measured with the general question: "*In general would you say your health is…*" with 5 answers to choose from: excellent, very good, good, fair and poor. This variable was maintained as categorical for descriptive purposes, but for multivariate analysis I preferred to allocate scores for the different categories, which reflect the inequality between the available categories (excellent -100, very good -85, good – 60, fair- 25, poor - 0). This scoring is used by the SF36 Health survey (Ware 1993).

Risk perception was measured with: "*How worried are you about getting WNV? Are you very worried, a little worried, not worried at all, don't know.*" For the purpose of this study this variable was recoded in a dichotomous way (worried/not worried).

Agreement with mosquito control measures: *"In Alberta, mosquito control interventions initiated by communities may include draining standing water and using chemicals to keep mosquitoes from hatching. These chemicals are called larvicides. Would you agree to the use of mosquito control programs in your area to reduce the number of mosquitoes?" Yes, No, Don't know*. For further analysis, this variable was recoded as dichotomous (yes/no).

Those who answered no or don't know, were further asked: "*What are some of the reasons you would not agree (or don't know if you would agree) to the use of mosquito* *control programs in your area?* " This was an open question with responses being categorized and recorded by interviewer in one of the following themes: no insects/pest problems, child health, adults health, pet/livestock health, environmental protection, unsafe/hazardous, too expensive, not enough information about risks, other (specify), don't know.

Behaviours

Personal protective behaviours: *"Thinking back to last summer, at times when you might be bitten by a mosquito, how often did you do the following things? Restrict outdoor activities, avoid places where the mosquitoes were a problem, wear long sleeves and pants, wear light coloured clothing, avoid the time of day where mosquitoes were most active (dusk and dawn), wear mosquito repellent."* Response options were: always, most of the times, sometimes, rarely, never. These categories were assigned values from 4 (always) to 0 (never).

Further, respondents were asked:" *If you did not use repellent, why not?* " This was an open question with responses categorized under the following: concerned about the use of chemicals, perceived low risk of getting WNV, did not see mosquitoes, concerned over interaction with sunscreen, too much trouble, cost too much, other (specify).
The respondents were questioned about whether their repellent contained DEET, and if not which were the reasons for not choosing a DEET repellent. These last two questions were not the object of the current study.

Environmental risk reduction activities: *"Last summer did you or anyone in your household do any of the following things to reduce the number of mosquitoes around your house? Put screens on windows or doors that previously had none? Repaired screens that had tears or holes in them? Checked and cleaned all rain gutters as required? Regularly emptied or replaced pools of standing water?"* The response options were yes, no, does not apply, don't know.

The risk of acquiring WNV as a result of failing to follow environmental risk reduction activities in the home environment was also analysed. For this purpose only respondents for which the question applied were selected. Further, yes was coded as 1 and no as 0. A composite risk measure was further constructed by summing the 4 activities, which took values 0 to 4.

Hours spent outdoors. Respondent were asked how much time they spent outdoors both on a typical workday and a non-work day, between July and September 2003, during the following hours: early morning, day time, evening, and night time. The hours were averaged for each respondent and described in two variables: hours spent outdoors during high risk time, and hours spent outdoors during low risk time for WNV transmission.

Knowledge

Respondents were asked whether they had heard about WNV prior to the survey, whether they were aware if WNV had been detected in both mosquitoes and people in Alberta. They were also asked to identify from a provided list the WNV transmission modes and the age group that is more likely to suffer severe complications of WNV infection. For analytic purposes a knowledge composite measure was developed in the AHW study, which quantifies the correct answers to the knowledge questions, and also awareness that WNV was detected in people in Alberta (a yes/no variable).

Demographics variables available and included in the present study were:

- Gender (male/female);
- Education. This variable has 8 categories in the initial survey (elementary, senior high-incomplete, senior high complete, college or technical school incomplete, college or technical school complete, university incomplete, university-complete, graduate degree). For the use in logistic regression analysis the above were reduced to 4 categories (elementary, secondary, college/technical, and university);
- Age groups. Initially there were 6 age groups (18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and over 65). Again, for performing logistic regression analysis

the above were reduced to 3 age groups (below 35 years, 35-54 years, and 55 years and older).

4.2.2.2. Weighting and bootstrapping

In order to be able to make inferences from the survey sample to the population, the sample weights derived for the AHW study were used. These weights are applied to each individual in the survey sample to reflect the probability of being selected for participation and to maintain the representativeness of the sample. The algorithm to perform the weighting took into account population estimates for each strata, household size, and number and telephone lines in each household. Weights were, in addition, post stratified by age and gender.

Sets of alternate weights were derived by repeating these procedures on 200 bootstrap samples. These weights were used to derive the standard errors for the estimates from survey data. The use of bootstrap method was required by the complex sample design (Rust et al. 1996).

The bootstrap is related to the concept of sampling distributions of sample statistics used to make statistical inferences. It is a computer intensive method for creating a sample distribution from just one sample. It is based on creation of hundreds of bootstrap samples by sampling with replacement from the original random sample. Further, the bootstrap standard error of a statistic is obtained by calculating the standard deviation of that statistic across calculations in each of the bootstrap samples. The main advantage of the bootstrap method is its robustness; it provides accurate results while making fewer assumptions than classical methods (e.g. distribution does not need to be normal) (Hjorth 1994).

4.2.2.2. Statistical testing

Data were analyzed using SPSS statistical software version 13.0.

Descriptive statistics were calculated on the study sample and the survey variables of interest.

Multivariate analyses were used to estimate associations of interest. Both multiple linear regression and logistic regression were used depending on the nature of the outcome variable. Multiple linear regression was used when the outcome variable was continuous. Logistic regression was used whenever the outcome variable was binary. Analyses used the survey weights. Each analysis was repeated 200 times to compute bootstrap standard errors for the parameter estimates. Bootstrap standard errors were further used to perform the tests for statistical significance.

Health status and the impact on attitudes and behaviours

First, a descriptive analysis of the health status variable was performed, and then the relationship between health status and other demographic variables (age, gender, education) was investigated. Statistical testing was used to determine whether health status was a significant predictor for being worried and agreeing with mosquito control measure after controlling for demographic variable and level of knowledge about WNV. Logistic regression was used as both these attitudes were described by dichotomous variables.

In the case of agreement with control measures the results prompted a more detailed analysis of the relationship between gender, risk perception (being worried) and agreement with control measures. I further tested whether gender was predictive for most commonly reported reasons for not agreeing with mosquito control measures (environmental protection, unsafe/hazardous, and not having enough information. Logistic regression was used to account for age, education and health status).

For the relationship between health status and behaviours the statistical testing aimed to determine whether health status was a significant predictor for engagement in particular personal preventive behaviours, after controlling for demographic variables and being worried. Multiple linear regressions were used as variables describing these behaviours were continuous.

Survey participation

In the beginning, a description of the seroprevalence sample was made, and demographic differences between the telephone survey and the seroprevalence samples were identified. The descriptive analysis also addressed the survey dynamics (response rates for the both phases of the AHW study).

Logistic regression was used to identify predictors for participation in the second phase of the AHW study (donation of a blood sample). A purposeful approach was chosen for inclusion of various variables in the model. The following variables were included in the model: demographic variables (age, education, and gender), health status, risk perception, knowledge composite variable, awareness about WNV being detected in people in Alberta, and laboratory available at the place of residence. Separate analyses were performed for the province-wide and Palliser samples.

Further, the analysis addressed the potential impact of the demographic differences identified between the survey and subsequent seroprevalence sample on the seroprevalence estimates. A comparison between the predictors of participation and predictors of being seropositive was made in order to document this issue.

The analysis on participation also aimed to identify whether less apparent behavioural differences exist between participants and non-participants in the second phase of the study, and might have impacted on the validity of seroprevalence estimates. For this purpose, the behavioural differences were analysed in a manner that reflect the risk of acquiring WNV infection. Repellent use was considered and expressed as a variable with highest value for never used repellent, and lowest value for always used repellent. The repellent was considered separate from all the other protective behaviours, as it is definitely the most effective protective behaviour. Similar variables were constructed for each of the remaining behaviours and then they were included in a composite variable that reflects the risk of WNV infection by not practicing these behaviours altogether.

Risk reduction activities performed in the respondents' home environment were also considered. A higher value was attributed for lack of these activities. The last variable included in this particular analysis was the time spent outdoors, as it represents a risk factor for acquiring WNV infection.

5. RESULTS

5.1. How does self perceived health status influence WNV- related attitudes and behaviours?

5.1.1. Demographic characteristics of the sample

Unweighted data were used to provide a profile of the study participants (Table 2).

From the total of 3780 survey respondents, 1889 were from Palliser Health Region. Among them 59.9 % were from urban areas, while 40.1 % were from rural areas. Among those outside Palliser, 53.4 % of the 1891 survey respondents were from urban areas; the remaining 46.6 % were rural residents.

Some demographic categories were under-sampled, while others were over-sampled when compared with their distribution in the Alberta 2003 population:

- Those aged 18-24 were under-sampled (8.1%) compared with 13.7% in the Alberta population.
- Females were over-sampled (63.3%) compared with 50% in the Alberta population
- Males were under-sampled (36.7%) compared with 50% in the Alberta population

The post stratification of weights takes these demographic differences into account for any analytic purposes.

Table 2: Demographic characteristics of the survey sample

		PALLISER HEALTH REGION (N=1,889)				REST OF PROVINCE (N=1,891)			
		Urban (n=1,132)		Non-urban (n=757)		Urban (n=1,010)		Non-urban (n=881)	
		Count	Col%	Count	Col%	Count	Col%	Count	Col%
Sex	Male	383	33.8%	265	55.0%	413	40.9%	325	36.9%
	Female	749	66.2%	491	64.9%	597	59.1%	556	63.1%
	N.R.			1	.1%				
Age	18- 24 yrs	84	7.4%	68	9.0%	109	10.8%	46	5.2%
	25- 34 yrs	168	14.8%	134	17.7%	176	17.4%	127	14.4%
	35- 44 yrs	267	23.6%	179	23.6%	236	23.4%	215	24.4%
	45- 54 yrs	265	23.4%	191	25.2%	240	23.8%	191	21.7%
	55- 64 yrs	177	15.6%	92	12.2%	145	14.4%	151	17.1%
	65and over	170	15.0%	93	12.3%	102	10.1%	150	17.0%
	N.R.	1	.1%			2	.2%	1	.1%
Education	Elementary ,junior high or less	63	5.6%	45	5.9%	32	3.2%	71	8.1%
	Senior high-incomplete	108	9.5%	77	10.2	45	4.5%	82	9.3%
	Senior high-complete	280	24.7%	228	30.1%	207	20.5%	227	25.8%
	College/ technical incomplete	100	8.8%	53	7.0%	68	6.7%	41	4.7%
	College/ technical complete	350	30.9%	217	28.7%	286	28.3%	264	30.0%
	University-incomplete	44	3.9%	29	3.8%	65	6.4	31	3.5
	University-complete	159	14.0%	83	11.0%	256	25.3%	131	14.9%
	Graduate degree	24	2.1%	16	2.1%	47	4.7%	22	2.5%
	N.R.	4	.4%	9	1.2%	4	.4%	12	1.3%

5.1.2. Self-perceived health status

Over 69% of respondents described their health as excellent or very good (Figure 3). The mean health status score was 76.8% (76.79±0.6). No significant differences were found between Palliser/rest of province, urban/rural, males/females. Figure 4 shows that the health status score decreases with age. In Figure 5 we see that the health status score increases with education.

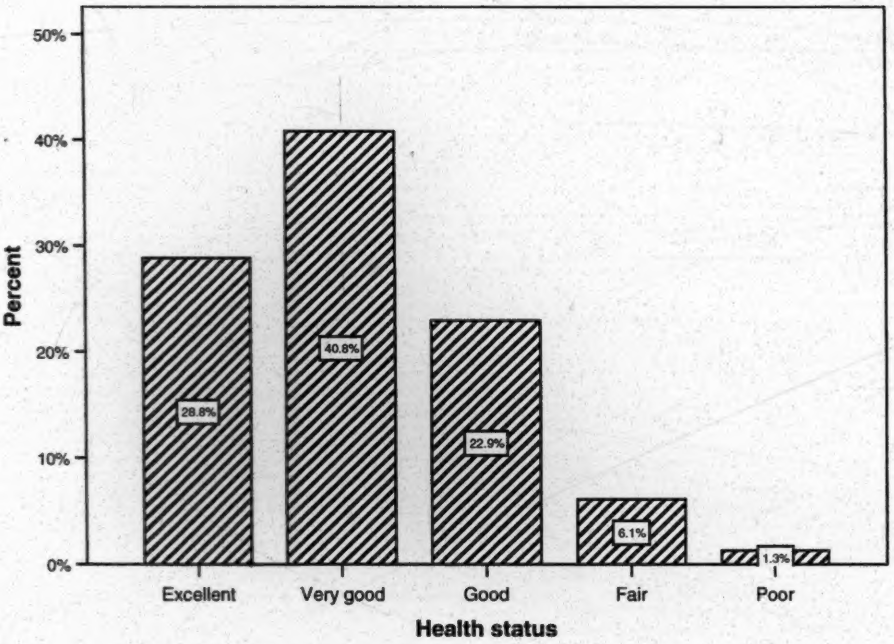

Figure 3: Self-perceived health status

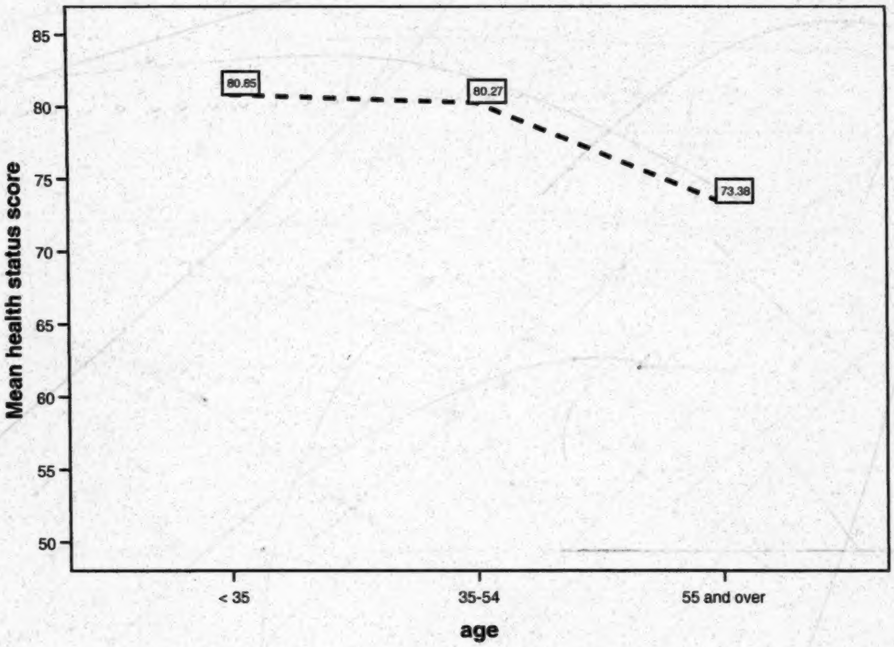

Figure 4: Health status and age

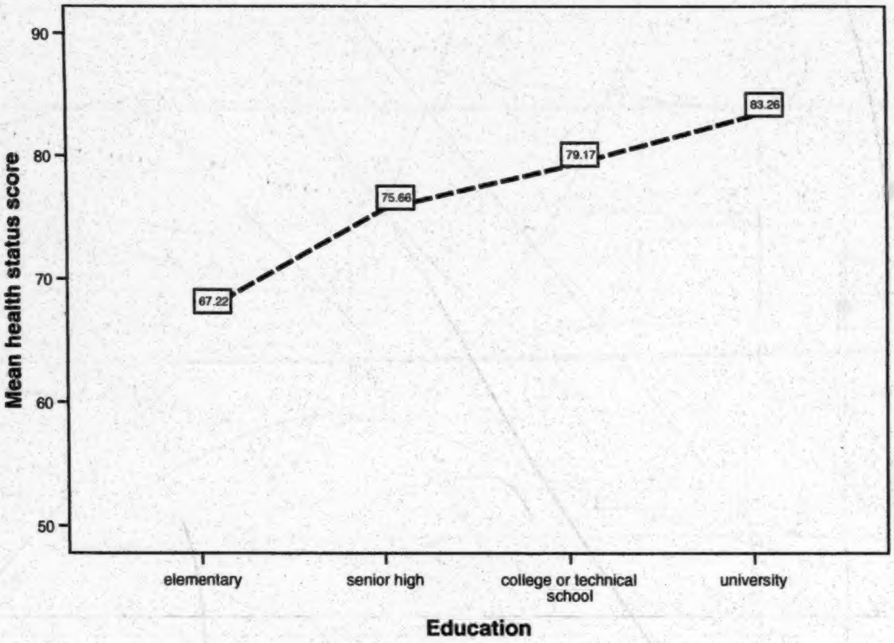

Figure 5: Health status and education

Linear regression was used to identify demographic predictors for health status. The results are presented in Table 3.

Table 3: Health status and demographic predictors

	Unstandardized coefficients		**Standardized coefficients**	**t**	**Statistical significance**
	B	*Bootstrap generated standard error*	*Beta*		
(Constant)	72.664				
Age	-1.866	.472	-.135	-3.96	p<0.001
Gender	-.294	1.251	-.007	-.23	ns
Education	.201	.030	.186	6.73	p<0.001
Urban/rural	-.614	1.19	-.013	-.52	ns
Palliser	.921	.898	.007	1.03	ns

Self perceived health status score increase with education and decrease with age.

The relation that exists between health status and age/education is a reason to control for both age and education in further analysis of the effect of health status on attitudes and behaviours variables.

5.1.3. Self perceived health status and attitudes

At provincial level there was an even split between those worried 49.2% (49.2 ±1.4) and not worried 50.8% (50.8±1.4), but differences were found between strata. In Palliser (Figure 6) more were worried (67%) compared with the rest of province (48.6%). Another significant difference was found between male and females (Figure 7), with females being more worried (58%females, vs. 41% males).

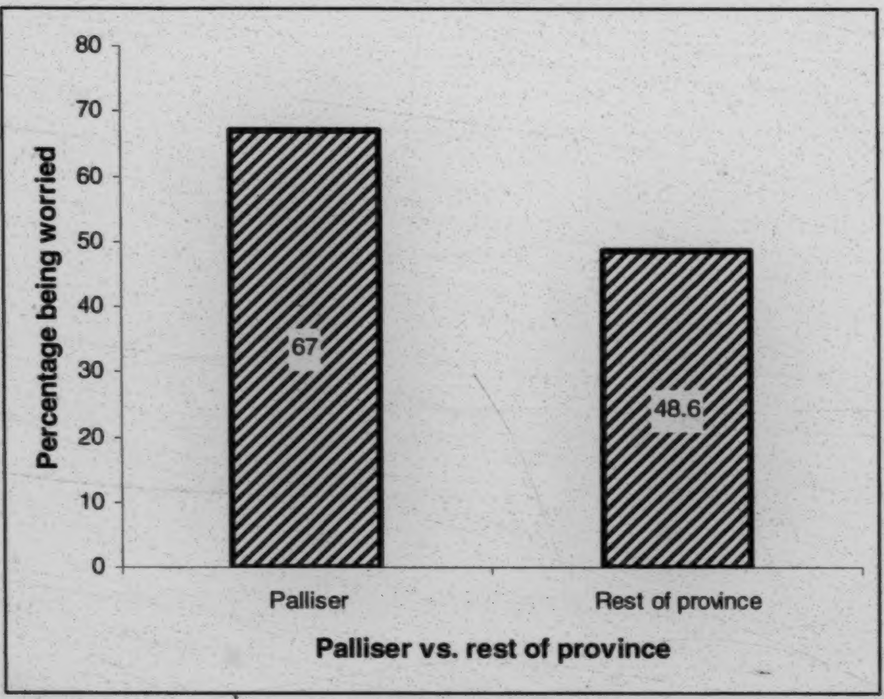

Figure 6: Worried about getting WNV in Palliser vs. rest of province

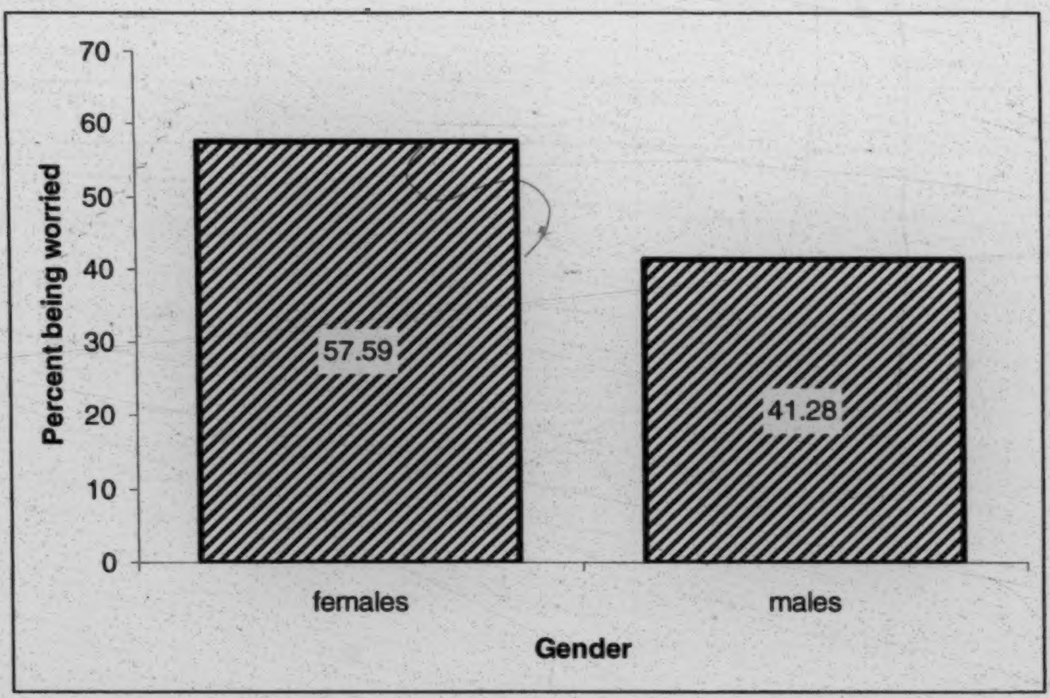

Figure 7: Worried about WNV and gender

No interaction was found between gender and location.

Logistic regression was used to see whether health status was a significant predictor for being worried (Table 4).

Table 4: Predictors for being worried (logistic regression)

Variables	Beta	Df	Odds Ratio	95% Confidence intervals for Odds Ratio (Bootstrap generated)		Statistical significance
Health status score	-.006	1	.994	.9890	.9990	p<0.05
Age (relative to 55 and older)		2				
Age <35	-.688	1	.503	.3595	.7026	p<0.05
Age 35-54	.022	1	1.022	.7695	1.3579	ns
Education	.001	1	1.001	.9951	1.0069	ns
Female	.670	1	1.953	1.5420	2.4767	p<0.05
Urban	-.184	1	.832	.6834	1.0128	ns
Palliser	.780	1	2.182	1.8607	2.5575	p<0.05
Knowledge composite	-.071	1	.931	.8532	1.0169	ns
Constant	.852	1	2.345			

Respondents were more likely to be worried about getting WNV if their perceived health status was lower, were female and were residents of Palliser health region; those in the age group <35 (compared with those 55 and over) were less likely to be worried.

An equivalent interpretation of the above regression analysis is: OR=.994 is the adjusted odds ratio of being worried associated with a unit increase in health status score after adjusting for age, gender, education, urban/rural, Palliser/rest of province and knowledge. Because health status is a continuous variable, the OR associated with it (Table 4) cannot be directly compared with the OR for age, female, and Palliser which are all categorical variables.

Province wide, more than 80% (81.5%±1.1) of respondents agreed with mosquito control measures (Figure 8).

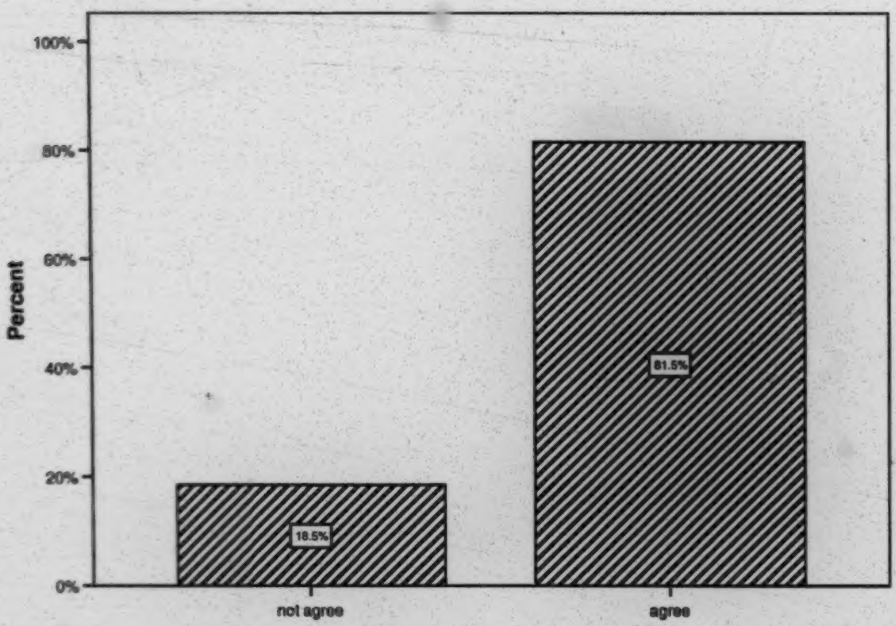

Figure 8: Agreement with mosquito control measures

Most often reported reasons for not agreeing were: protection of environment (7.9%±0.7), the use of unsafe/hazardous chemicals (6.2%±0.7), and not having enough information about the risks associated with mosquito control measures (5.1% ±0.6).

Linear regression was used to identify whether health status was a significant predictor for agreeing with mosquito control measures (Table 5).

Table 5: Predictors for agreeing with mosquito control measure (logistic regression)

Variables	Beta	Df	Odds Ratio	95% Confidence intervals for Odds Ratio (Bootstrap generated)		Statistical significance
Health status score	.001	1	1.001	1.00	1.01	ns
Age (relative to 55 and older)						
Age <35	-.311	1	.733	.48	1.13	ns
Age 35-54	-.080	1	.923	.62	1.38	ns
Education (relative to university)						
elementary	.233	1	1.263	.57	2.78	ns
secondary	.206	1	1.229	.83	1.83	ns
college	.180	1	1.197	.83	1.72	ns
Female	-.662	1	.516	.37	.71	$p<0.05$
Urban	.380	1	1.463	1.14	1.88	$p<0.05$
Palliser	.356	1	1.427	1.18	1.73	$p<0.05$
Knowledge composite	-.039	1	.962	.87	1.07	ns
Not worried	-.491	1	.612	.45	.83	$p<0.05$
Constant	1.968	1	7.157			

Respondents were more likely to agree with mosquito control measures if they were males, live in Palliser, live in urban areas and were worried about getting WNV. Health status was not a significant predictor for agreeing with mosquito control measures.

I further investigated whether gender was a predictor for most commonly mentioned reasons for not agreeing with mosquito control measures: environmental protection, unsafe/hazardous and not enough information about risks.

Being female significantly predicted reporting pesticides as unsafe/hazardous, after controlling for age, education and health status (Table 6).

Table 6: Not agree because unsafe/hazardous (logistic regression)

Variables	**Beta**	**Df**	**Odds Ratio**	**95% Confidence intervals for Odds Ratio (Bootstrap generated)**		**Statistical significance**
Female	.627	1	1.872	1.08	3.24	p<0.05
Age (relative to 55 and older)		2		.	.	
Age <35	.650	1	1.916	.96	3.82	ns
Age 35-54	.409	1	1.505	.80	2.82	ns
Education (relative to university)		3		.	.	
elementary	.515	1	1.674	.41	6.86	ns
senior high	-.482	1	.618	.32	1.18	ns
college/technical	-.238	1	.789	.46	1.36	ns
Health status score	-.003	1	.997	.99	1.01	ns
Constant	-3.040	1	.048	.	.	

5.1.4. Self perceived health status and behaviours

Multiple linear regression was used to determine whether health status was a significant predictor for engaging in each of the following personal protective behaviours: restricting outdoor activities, avoiding places where mosquitoes were a problem, wearing protective clothing, and using mosquito repellent.

Respondents were more likely to avoid places where mosquitoes were a problem if they were females and were worried. Health status did not significantly predict this particular behaviour (Table 7).

Table 7: Predictors for avoiding places where mosquitoes were a problem

	Unstandardized coefficients		**Standardized coefficients**	**t**	**Statistical significance**
Variables	*B*	*Bootstrap generated standard error*	*Beta*		
(Constant)	1.595				
Health status score	-.002	.001669	-.037	1.2	ns
Urban/rural	-.079	.070775	-.027	1.2	ns
Palliser vs. the rest of the province	.041	.051042	.005	.8	ns
Education	-.003	.021032	-.005	.1	ns
Age	-.014	.025239	-.017	.6	ns
Gender	-.229	.081664	-.087	2.8	p<.01
Worried/not worried	.471	.074773	.179	6.3	p<.001

Respondents were more likely to wear protective clothing if they live in rural Palliser, were of older age, were males, and were worried about getting WNV. Health status did not significantly predict this particular behaviour (Table 8).

Table 8: Predictors for wearing protective clothing

	Unstandardized coefficients		**Standardized coefficients**	**t**	**Statistical significance**
Variables	*B*	*Bootstrap generated standard error*	*Beta*		
(Constant)	1.177				
Health status score	-.002	.001405	-.042	1.42	ns
Urban-rural	.197	.058950	.076	3.34	p<0.001
Palliser vs. the rest of the province	.110	.042918	.016	2.56	p<0.05
Education	-.034	.018907	-.054	1.8	ns
Age	.100	.024934	.135	4	p<0.001
Sex	.163	.067036	.069	2.43	p<0.05
Worried/not worried	.347	.062661	.147	5.5	p<0.001

Respondents were more likely to restrict outdoor activities if their perceived health status was lower, were residents of Palliser, were females, and were worried about getting WNV (Table 9).

Table 9: Predictors for restricting outdoor activities

	Unstandardized coefficients		**Standardized coefficients**	**t**	**Statistical significance**
Variables	*B*	*Bootstrap generated standard error*	*Beta*		
(Constant)	.876				
Health status score	-.003	.001211	-.079	2.5	p<.05
Urban-rural	.073	.051034	.036	1.4	ns
Palliser vs. the rest of the province	-.123	.039024	-.023	3.2	p<.01
Education	.009	.012808	.019	.7	ns
Age	-.014	.018626	-.024	.8	ns
Sex	-.234	.048459	-.128	4.8	p<.001
Worried/not worried	.461	.047341	.253	9.7	p<.001

Respondents were more likely to use repellent if were they perceived their health status as higher, were of younger age, females, worried, and spent more time outdoors at hours of risk (Table 10).

Table 10: Predictors for repellent use

	Unstandardized coefficients		**Standardized coefficients**	**t**	**Statistical significance**
Variables	B	Bootstrap generated standard error	Beta		
(Constant)	1.651				
Health status score	.007	.002191	.109	3.2	p<.01
Urban-rural	.122	.089632	.043	1.4	ns
Palliser vs. the rest of the province	-.072	.060672	-.010	1.2	ns
Education	.002	.026355	.003	.1	ns
Age	-.077	.037720	-.083	2.0	p<.05
Sex	-.318	.087220	-.123	3.7	p<.001
Worried/not worried	.397	.092977	.156	4.3	p<.001
Time in high risk times	.006	.003054	.083	2.0	p<.05
Time in low risk times	-.002	.003395	-.028	.6	ns

Table 11 summarizes the significant predictors found for each of the personal preventive measure analysed. Self perceived health significantly predicted restricting outdoor activities and using repellent.

Table 11: Predictors for protective measures (summary)

Protective measure	Significant predictors
Avoid places where mosquitoes were a problem	Female, worried
Wear protective clothing	Palliser, rural, age, males, worried
Restrict outdoor activities	**Health status**, Palliser, female, worried
Use repellent	**Health status**, age, female, worried, time spent outdoors at high risk times

5.2. Survey participation

5.2.1. Characteristics of the seroprevalence sample

Unweighted data were used to provide a profile of the study participants in phase II of the study (blood collection) (Table 12).

Differences in demographic characteristics between the survey and seroprevalence sample are as follows (Tables 2 and 12):

For the Palliser strata:

- those in age groups <35 are underrepresented compared with the survey sample
- those in the age groups over 55 are overrepresented
- those with university education are overrepresented

For the rest of the province strata:

- those in age groups <35 are underrepresented compared with the survey sample
- those in the age groups over 55 are overrepresented
- those with either elementary or university education are overrepresented
- those with senior high education are underrepresented.

These data suggests a tendency of increased participation in the seroprevalence component of the study of those of older age and higher education.

Table 12: Demographics of the seroprevalence sample

		Palliser Health Region (n=1,320)				Rest of province (n=1,198)			
		Urban (n=786)		Non-urban (n=534)		Urban (n=630)		Non-urban (n=568)	
		Count	Col%	Count	Col%	Count	Col%	Count	Col%
Sex	Male	266	33.8%	176	33.0%	254	40.3%	195	34.3%
	Female	520	66.2%	357	66.9%	376	59.7%	373	65.7%
	N.R.			1	.2%				
Age	18- 24 yrs	25	3.2%	24	4.5%	34	5.4%	10	1.8
	25- 34 yrs	72	9.2%	65	12.2%	79	12.6%	48	8.5%
	35- 44 yrs	169	21.5%	126	23.6%	145	23.1%	120	21.1%
	45- 54 yrs	203	25.9%	153	28.7%	156	24.8%	143	25.2%
	55- 64 yrs	158	20.1%	84	15.7%	124	19.7%	119	21.0%
	65 and over	158	20.1%	82	15.4%	90	14.3%	128	22.5%
Education	Elementary, junior high or less	52	6.6%	27	5.1%	24	3.8%	57	10.0%
	Senior high - incomplete	73	9.3%	62	11.6%	24	3.8%	48	8.5%
	Senior high - complete	186	23.7%	140	26.2%	105	16.7%	124	21.8%
	College or technical school -incomplete	57	7.3%	34	6.4%	37	5.9%	27	4.8%
	College or technical school - complete	236	30.0%	166	31.1%	192	30.5%	170	29.9%
	University - incomplete	34	4.3%	20	3.7%	42	6.7%	24	4.2%
	University - complete	126	16.0%	64	12.0%	170	27.0%	96	16.9%
	Graduate degree	19	2.4%	13	2.4%	33	5.2%	13	2.3%
	N.R.	3	.4%	8	1.4%	3	5%	9	1.6%

5.2.2. Survey dynamics

Response rates

For the telephone survey the response rate was 32% (Table 13). Response rate was 35% in Palliser and 29% in the rest of the province.

Table 13: Response rates for the telephone survey

	Rest of province	**Palliser**	**Total**
Completes	1,891	1,889	**3,780**
Refusals	4,541	3,511	**8,052**
Total	6,432	5,400	**11,832**
RR	29%	35%	**32%**

For the blood sample collection the response rate was 67% (Table 14). The response rate was 70% in Palliser and 63% in the rest of the province.

Table 14: Response rate for blood sample collection

	Palliser	**Rest of province**	**Total**
Laboratory requisitions mailed out	1,889	1,891	3,780
Blood samples received at provincial Lab	1,320	1,198	2,518
Response rate	**70%**	**63%**	**67%**

The median duration between survey date and blood donation at the designated requisition sites was 15 days (minimum 1day, maximum 140 days) (Figure 9). Seventy five percent of participants in the second phase of the study donated a blood sample in the first month after the telephone survey.

Respondents not submitting a blood sample in the first two weeks after the telephone survey received up to 2 follow–up letters. The second peak in blood submission visible on the graph (Figure 9) around 35 days, most likely corresponds to the first follow up with respondents. The second follow-up did not appear to have a comparable impact as the first one.

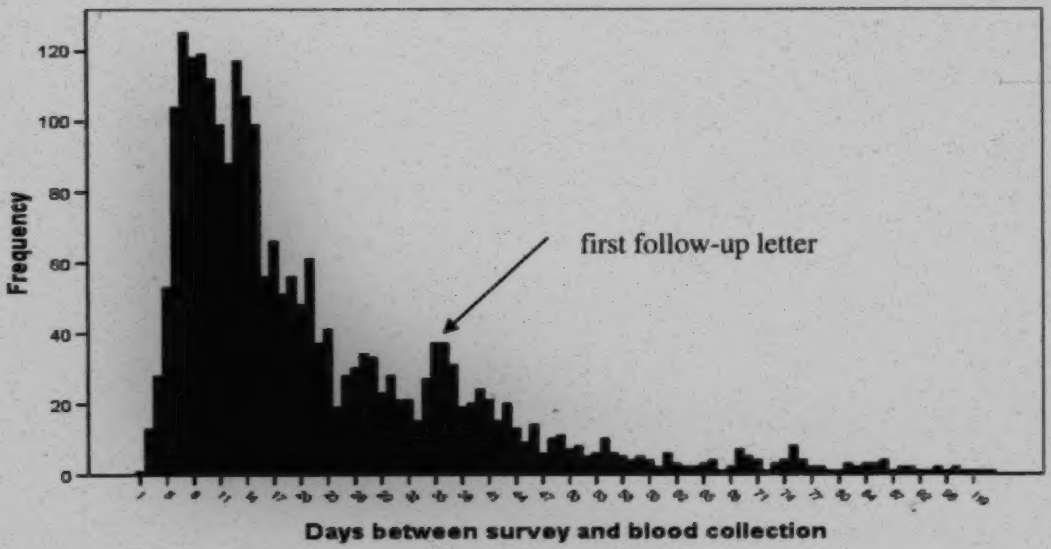

Figure 9: Response of participants for providing a blood sample

5.2.3. Predictors for blood donation

Respondents were more likely to donate blood if were over 55 yrs old, were females and were residents in Palliser health region; those with secondary education (compared with university education) were less likely to donate blood. Laboratory present at place of residence was not a significant predictor of participation. Health status was not a significant predictor either (Table 15).

In Palliser health region respondents were more likely to donate blood if were over 55 years old, and less likely to donate blood if have secondary education (compared with those with university education. Laboratory present at place of residence and health status were not significant predictors of participation (Table 16).

Table 15: Predictors for blood donation - province

Variables	Beta	Df	Odds Ratio	95% Confidence intervals for Odds Ratio (Bootstrap generated)		Statistical significance
Age (relative to 55 and older)		2				
Age <35	-2.622	1	.073	.04	.12	p<0.05
Age 35-54	-1.488	1	.226	.15	.33	p<0.05
Female	.327	1	1.386	1.004	1.92	p<0.05
Education (relative to university)		3				
elementary	-.099	1	.906	.32	2.53	ns
secondary	-.769	1	.464	.31	.70	p<0.05
college	-.155	1	.857	.57	1.29	ns
Urban	.172	1	1.187	.84	1.68	ns
Palliser	.403	1	1.496	1.19	1.88	p<0.05
Knowledge composite	.034	1	1.035	.93	1.15	ns
Not aware WNV in people	.194	1	1.214	.78	1.89	ns
Not worried	-.168	1	.846	.62	1.16	ns
Health status score	.006	1	1.006	1.00	1.01	ns
Laboratory not available	.128	1	1.136	.69	1.87	ns
Constant	1.474	1	4.368			

Table 16: Predictors for blood donation-Palliser

Variables	Beta	Df	Odds Ratio	95% Confidence intervals for Odds Ratio (Bootstrap generated)		Statistical significance
Age(relative to 55 and older)		2				
Age <35	-2.741	1	.065	.04	.10	P<0.05
Age 35-54	-1.509	1	.221	.15	.33	P<0.05
Female	.282	1	1.326	.30	1.83	ns
Education (relative to university)		3				
elementary	-.173	1	.841	.36	2.35	ns
secondary	-.601	1	.548	.60	.83	P<0.05
college	-.107	1	.899	.76	1.35	ns
Urban	.079	1	1.083	.98	1.53	ns
Knowledge composite	.081	1	1.084	.52	1.21	ns
Not aware WNV in people	-.223	1	.800	.70	1.24	ns
Not worried	-.048	1	.953	.96	1.30	ns
Health status score	.003	1	1.003	1.00	1.01	ns
Laboratory not available	.239	1	1.270	.77	2.09	ns
Constant	1.677	1	5.348			

5.2.4. Risk of infection

5.2.4.1 Demographic characteristics of seropositives

From the 35 respondents who tested positive for WNV infection, 30 were from Palliser region and 5 from the rest of the province. Among them 29 (82.9%) were from rural areas, while only 6 were from urban areas. Both genders (18 females and 16 males) and all age groups in the study were affected (Figure 10). Level of education distribution resembles the survey sample (Figure 11).

The AHW study reported that respondents were more likely to test seropositive for WNV infection if living in Palliser Health Region, and there is also a tendency for those reporting that always used repellent containing DEET to be less likely to test positive (although this association did not reach conventional levels of statistical significance). These data suggest that demographic characteristics (age, education, gender) were not significantly associated with seropositivity.

It is of further interest to see whether the sample available for determining the seroprevalence was any different in practicing protective behaviours compared with the initial survey sample and therefore at a different risk for acquiring WNV infection.

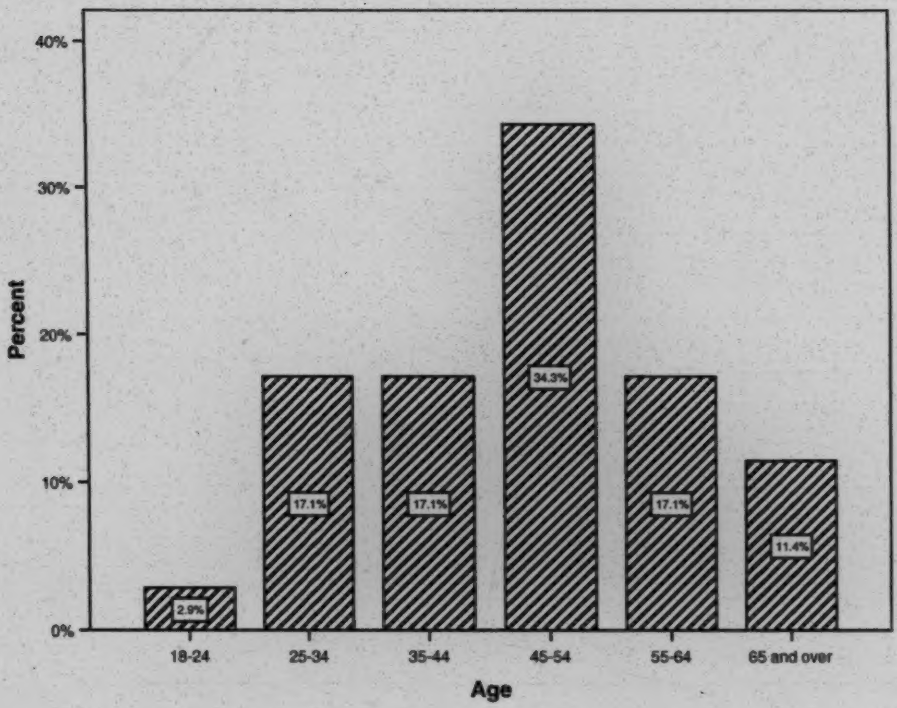

Figure 10: Age distribution for seropositives

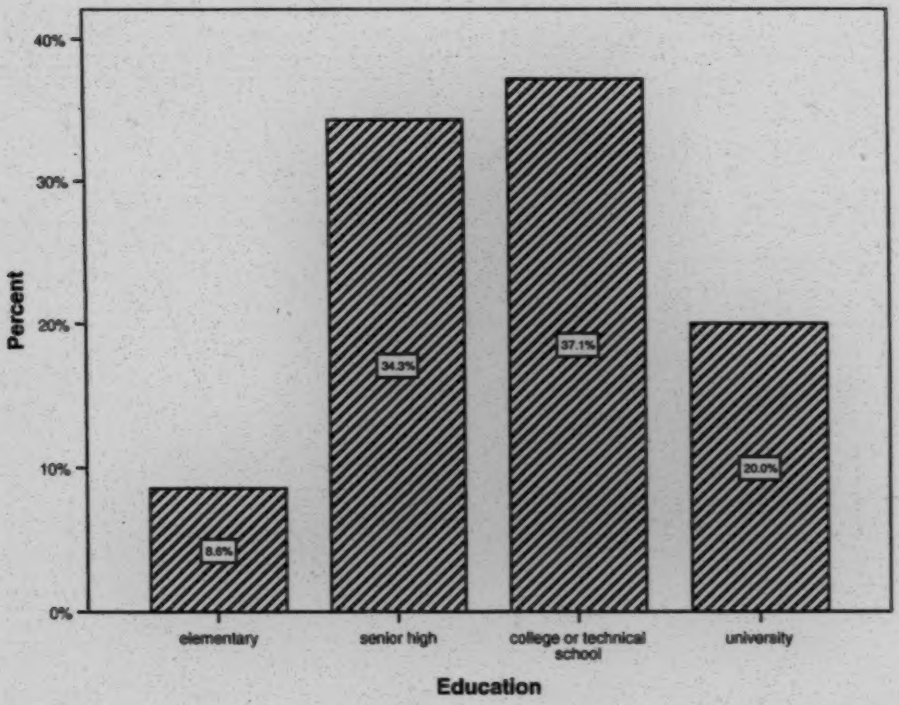

Figure 11: Level of education for seropositives

5.2.4.2 Differences in risk of infection between those who donated blood samples and those who did not

I quantified the risk of infection due to non-use of personal protective measures, lack of environmental reduction activities in the home environment and time spent outdoors. The mean values for each risk composite measure are presented in Table 17.

Table 17: Composite risk measures (mean values)

Risk due to:		Mean
Not using repellent	Participants	57.39
	Non-participants	50.80
Not using other protective measures	Participants	332.26
	Non-participants	338.23
Lack of environmental risk reduction measures around the house	Participants	1.26
	Non-participants	1.33
Hours spent outdoors	Participants	7.82
	Non-participants	8.85

I further used logistic regression to identify whether any significant differences were present between participants and non-participants in the second phase of the study in respect to risk composite measures taken together. Analysis was conducted for both province and Palliser.

Participants and non-participants in the second phase of the survey were similar in their risk of acquiring WNV infection (Tables 18 and 19). No differences were found in their protective behaviours, time spent outdoors or exposure in the home environment.

Table 18: Risk of WNV infection – province wide (logistic regression)

Variables	Beta	Df	Odds Ratio	95% Confidence intervals for Odds Ratio (Bootstrap generated)		Statistical significance
Repellent use	.004	1	1.004	1.00	1.01	ns
Other protective measures	.000	1	1.000	1.00	1.00	ns
Environmental risk reduction activities	-.008	1	.992	.88	1.12	ns
Times at high risk times	.005	1	1.005	.98	1.03	ns
Times at low risk times	-.010	1	.990	.97	1.01	ns
Constant	-.003	1	.997			

Table 19: Risk of WNV infection – Palliser (logistic regression)

Variables	Beta	Df	Odds Ratio	95% Confidence intervals for Odds Ratio (Bootstrap generated)		Statistical significance
Repellent use	.003	1	1.003	1.00	1.01	ns
Other protective measures	.000	1	1.000	1.00	1.00	ns
Environmental risk reduction activities	-.044	1	.957	.85	1.08	ns
Times at high risk times	.007	1	1.007	.99	1.03	ns
Times at low risk times	-.009	1	.991	.97	1.02	ns
Constant	.304	1	1.355			

6. DISCUSSION

The present study was intended to complement the AHW study; therefore this chapter interprets the results in the context of the related findings of the AHW study, as well as other WNV surveys conducted in North America. This will provide a wider perspective of the WNV related attitudes, risk perception and behaviours in Alberta.

6.1. Attitudes, risk perception and behaviours

6.1.1. The study sample

The AHW study represented the largest assessment of WNV infection in Canada to date; it provided not only an estimate of WNV seroprevalence in Alberta, but also an assessment of relevant attitudes and behaviours among Albertans. Compared with Alberta adult population, females were oversampled, those 18-24 were undersampled in the telephone survey sample; the post-stratification of weights took these into account, for analytic purposes. The stratification of the sample offered the possibility to perform comparisons between the strata, especially between an area with the highest reported number of cases and other areas in terms of WNV related risk perception, attitudes and behaviours. Besides apparent demographic differences between the seroprevalence sub-sample and the entire survey sample, less apparent behavioural differences, and consequent differences in the risk of acquiring the WNV infection, may have been present; their impact on the seroprevalence estimate were addressed in the current study.

6.1.2. Attitudes and risk perception

As intended, the findings of the current study have complemented those of AHW study. The nature of the relationship between attitudes and behaviours was explored in more detail. I attempted to explain them in the light of current knowledge originating in sociological and psychological research. A theoretical model was adopted a priori and the relationship between concepts was illustrated by testing the association between variables illustrating each concept. This study contributed to a more detailed description of the WNV related attitudes and behaviours in Alberta with direct application for future public health action.

In terms of risk perception, provincial estimates showed an even split between those who were worried and those who were not. More respondents were worried in Palliser, compared with the rest of province. Females were more worried than males (58% vs. 41%).

The present study was the first to explore in more detail the WNV related risk perception, by identifying predictors of being worried. Multivariate analysis revealed that respondents were more likely to be worried about getting WNV if their perceived health status was lower, were female and were residents of Palliser health region; those in the age group <35 (compared with those 55 and over) were less likely to be worried.

Demographic characteristics were associated with risk perception with females and those over 35 years old being more worried. The fact that females report to be more worried is an expected finding, as the gender difference is consistently found in risk perception studies. There are many explanations for this tendency, but the topic is still open. One possible explanation is the presence of a response bias, being more socially acceptable for women to reveal their anxiety. More in-depth explanations based on psychological studies, consider that the gender difference resides not at level of cognitive appraisal of risk but on more complex process of emotional and behavioural responses to that information, and that differences are found not only by gender, but also with gender interacting with race, nationality, and socioeconomic resources. Differences in social roles between male and females, with females expressing more nurturing behaviours, and being more concern about health and safety are also plausible explanations (Slovic 2000; Hitchcock 2001).

Beside gender differences, age differences in risk perception were not particularly addressed in previous WNV surveys either. The current study findings suggest that those in the age group less than 35 years old are less likely to be worried, compared with older respondents. This might be explained by the fact that younger people pay less attention to health issues in general, and therefore are less likely to be worried about health related issues.

Beside gender and age, knowing that a large number of people in a person's area of residence have already become ill, undoubtedly affects risk perception. This explains why respondents were more worried in Palliser, an area where many people become ill in 2003. Many people in Palliser also reported that they have heard about WNV from friends, and/or they knew someone who got the disease. WNV was, undoubtedly, an important topic in the Palliser region in 2003.

The survey question specified that, in Alberta, mosquito control programs consist of draining standing water and use of larvicides, as opposed to use of spraying used in other areas. The majority of respondents agreed with the use of these mosquito control measures. Previous studies in North America in general, and Canada in particular, have reported similar findings (Blendon et al. 2002; Elliott et al. 2003; HSPH 2005). These studies have also shown that in general, respondents from high mosquito areas, where these control measures have been extensively used in the past, before the arrival of WNV, were more likely to agree with their use.

Most often reported reasons for not agreeing with mosquito control measures were: protection of environment, the use of unsafe/hazardous chemicals, and not having enough information about the risks associated with mosquito control measures. All these were reported at low levels.

This study was also the first to document predictors for agreement with mosquito control interventions. Respondents were more likely to agree with mosquito control measures if they were males, live in Palliser urban areas, and were worried about getting WNV.

Despite increased concern about WNV, females were less likely to agree with mosquito control measures than males. This finding prompted further investigation to see whether gender was a predictor for the most commonly mentioned reasons for not agreeing with mosquito control measures: environmental protection, unsafe/hazardous and not enough information about risks. Being female significantly predicted considering pesticides as unsafe/hazardous, after controlling for age, education and health status. This further illustrates an aspect of the gender difference in risk perception, with females being more worried about getting WNV, but perhaps even more worried about potential negative consequences associated with the use of pesticides.

These findings also illustrate the negative imagery associated with pesticides, which are also often found by risk perception studies (Slovic 2000). Surveys conducted in Canada constantly reported respondents being worried about chemicals in general (Slovic et al. 1993) and those associated with mosquito control in particular (Elliott et al. 2003; Health_Canada 2003; Aquino et al. 2004).

Those living in a high risk area (i.e. Palliser) were more likely to agree with control measures. This is an expected finding, as the proximity of a threat perceived as important is more likely to induce attitudes and behaviours intended to eliminate the threat.

In summary, WNV related risk perception appears to be influenced by demographic characteristics (i.e. gender and age), and also by living in an area with known higher risk for infection. Further, risk perception (being worried) predicted the agreement with mosquito control measures, and also, as described in section 6.1.3., the practice of protective behaviours.

6.1.3. Behaviours

The AHW study , and previous WNV surveys conducted in North America ((Elliott et al. 2003; Wilson et al. 2005)), concluded that despite consistent awareness of WNV, few respondents consistently take precautions, a finding which mandated continuous public messaging about the importance of personal protective behaviours.

The AHW study addressed the overall practice of personal protective measures. Respondents were more likely to engage in personal protective measures overall if they were worried about contracting WNV, were female and spent more time outdoors during risk hours for virus transmission. The current study addressed each of the preventive behaviours separately. Respondents were more likely to avoid places where mosquitoes were a problem if they were worried and females. Respondents were more likely to wear protective clothing if they live in rural Palliser, were males, of older age and were worried about getting WNV. Respondents were more likely to restrict outdoor activities if they perceived their health status as lower, were females, residents of Palliser, and were worried about getting WNV. Respondents were more likely to use repellent if they were worried, female, of younger age, spent more time outdoors at hours of risk, and perceived their health status as higher. Risk perception, gender and age were constantly found as predictors for repellent use by previous surveys (McCarthy et al. 2001; Elliott et al. 2003; Wilson et al. 2005). Concern with the use of chemicals has been often reported as reason for not using repellent. Repellent is therefore perceived as a chemical with the associated negative imagery; and the fact that it has a beneficial capability of reducing the risk of WNV infection does not grant it a favourable perception (i.e. as it is the case with prescription drugs for example).

Being worried constantly predicted engaging in preventive behaviours. This illustrates the adopted theoretical framework with attitudes (in particular risk perception) influencing behaviour, even though no link was found between knowledge and attitudes.

Level of education did not have a significant impact on preventive behaviours in the current study. Due to WNV education campaign and media attention, the large majority of participants had received the necessary information on how to protect themselves against WNV, irrespective of their level of education.

WNV is a new topic in Alberta. Before its arrival in North America, there probably was little or no knowledge about it among Albertans. Prior the 2003 transmission season, when arrival of the virus in the province was considered imminent, a public education campaign was launched. As the season progressed and cases occurred, the WNV topic received special media attention. Given these unique circumstances, we can confidently consider that knowledge, attitudes and behaviours related to WNV captured by this survey were influenced by both the education campaign and media attention.

6.2. Health status and its impact on behaviours and attitudes

To my knowledge, this study represented the first attempt to investigate the relationship between self perceived health status and WNV related risk perception and personal protective behaviours. Health status appraisals in general and self-perceived health status in particular, have received increased attention in recent years, mostly in a clinical research context. From a public health primary prevention perspective, I believe, the topic deserves equal consideration.

The levels of self-perceived health status reported by participants were similar with previous Alberta surveys. Being a general population survey, as expected, the majority of respondents considered their health as very good or excellent.

Health status decreases with age, and increases with level of education. No gender differences were found. The association between health status and age/education justified to attempt controlling for these demographic variables in further analyses of the effect of health status on attitudes and behaviours.

Health status was a significant predictor for being worried after controlling for demographic variables (age, education, gender, urban/rural, Palliser/rest of the province) and level of knowledge about WNV.

Health status did not predict agreement with control measures.

Health status did not predict the overall practice of personal protective behaviours (as measured by the protective measures composite variable), but appeared to influence some particular behaviours (restricting outdoor activities and the use of repellent). Respondents were more likely to restrict outdoor activities if they perceived their Health status as lower. In contrast, those with a higher health status were more likely to use repellent.

Health status reflects general attitudes regarding one's health. It appears to further influence more particular attitudes regarding health (i.e., risk perception for WNV threat) and the nature of behavioural response to particular health threats (engaging in personal protective measures to reduce mosquito bites). Our findings suggest that those with a lower self perceived health status tend to worry more about getting WNV and to take extreme measures like restricting outdoor activities altogether. In contrast, those with a higher perceived health status do not restrict their outdoor activities, but are more likely to continue being active and spend time outdoors while protecting themselves with mosquito repellent. More research is mandated in this area to fully elucidate this relationship between general attitude on health and particular health related attitudes and behaviours.

I did not attempt to investigate associations between health status and engagement in environmental protective measure, as the current data does not allow it. The survey question inquired whether the respondent or someone else in their household had performed any environmental risk reduction activities; therefore I cannot discern whether respondents themselves had performed them.

Figure 12 summarizes the relationships between health status, demographics, risk perception and behaviours which were apparent in the present study. The weight of the arrows does not reflect in any way the strength of association; the relationship between health status and worried (risk perception) on one side, and between health status and behaviours on the other, were highlighted as they were the subject of my study. Health status was a significant predictor for being worried (Table 4). Health status significantly predicted engagement in preventive behaviours. Those with a lower perceived health status were more likely to restrict their outdoor activities (Table 9), while those with a higher perceived health status were more likely to use mosquito repellent (Table 10). Being worried was a significant predictor for engagement in all predictive behaviours (Tables 7, 8, 9, 10). Further being worried was the most important predictor of behaviours (had the largest effect on behaviours among the variables considered). Demographic variables were part of the complex relationship between attitudes (self perceived health status, being worried) and behaviours. Health status was influenced by age and education (see Table 3, and Figures 3 and 4). Age and gender significantly predicted being worried (Table 4) as well as engagement in preventive behaviours (Tables 7, 8, 9, 10).

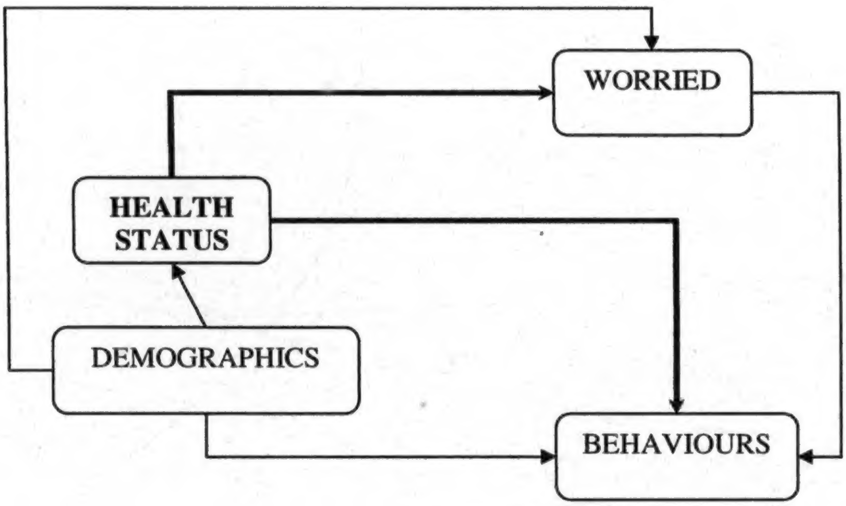

Figure 12: Relationship between health status, demographics, risk perception and behaviours

6.3. Survey participation

This study described in more detail than any previous surveys on WNV topic, aspects of survey participation and dynamics. It addressed the potential impact of non - participation on the study outcomes, and provided further evidence for the validity of the AHW study seroprevalence estimates. It described the experience of conducting the first WNV related survey in Alberta, and therefore it provides reference data for the design and implementation of future surveys.

The response rate for both phases of the AHW survey was very good given the requirements for participation. Response rates were lower compared with other telephone surveys addressing health concerns. Participation in the study involved agreement not only with the participation in the telephone survey, but also with the submission of a blood sample, which explains a lower response rate compared with surveys limited to answering questions. A similar study (involving telephone survey along with submission of a blood sample) reported 25% response rate (Elliott et al. 2003).

WNV was a new topic in Alberta and therefore the survey was more likely to capture the interest of potential responders. Many people were obviously curious to know whether they had been infected with the virus or not. It had been decided that following the AHW survey the respondents would be contacted by the regional health authorities in the case that they tested positive for WNV; participation in the survey was therefore an opportunity for respondents to know if they had been infected. Interest in the study results it is known to motivate participation. It is also worth mentioning that the study team has also received several requests from Albertans who had heard about the study, wishing to volunteer for the survey.

Further, careful planning and monitoring of data collection, as well as employment of an experienced interview team contributed to a good response rate. The interview times were scheduled to best accommodate respondents' characteristics. Several attempts, at different times were made both during workdays and weekends before dropping a telephone number as non-response.

The survey respondents were followed up in order to increase participation in the second phase of the study. Respondents not submitting a blood sample in the first two weeks after the telephone survey received a maximum of 2 follow-up letters. Unfortunately, an accurate estimate of the follow-up effect on increasing the participation cannot be obtained. The blood collection, involving transportation of the blood samples to the Provincial Laboratory, sometimes generated a delay (up to one week) between the date of blood donation and the update from the lab acknowledging it; therefore some respondents receiving a follow-up letter might have actually donated the blood before receiving the letter.

Response rate was higher in Palliser, compared with the rest of the province, for both the telephone survey and the blood collection. This finding confirms once again that participation is influenced by the importance potential participants give to the survey topic. WNV was an important topic in Alberta and even more in Palliser, given the high number of clinical WNV infections in this region during 2003 season. The attention given in the media has also influenced the high ranking of importance of this topic.

Respondents were more likely to donate blood if they were over 55 years old, were female and were residents in Palliser health region; those with secondary education (compared with university education) were less likely to donate blood. The increased participation from elderly might be explained by having more time for volunteering, rather than greater motivation. They might also be more likely to keep their promises. It should also be mentioned that some collection sites, especially outside big cities have limited working hours, being usually open in the morning. This might have made participation more difficult for younger working adults who would have had to take time off from work in order to donate a blood sample.

Having a laboratory present near the place of residence was not a significant predictor of participation. This suggests once again, that participation was rather influenced by the participant considering WNV an important topic, which deserved the effort to go to a lab and donate a sample. This is especially remarkable for respondents in rural areas who had to travel sometimes a considerable distance to a blood collection site.

Figure 13 summarizes the relationship between demographics, risk perception and participation. Being worried was not a statistically significant predictor for providing a blood sample in the multivariate analysis (Tables 15 and 16); its effect becomes non significant after adjusting for gender and age. Data do show a tendency of those being less worried to be less likely to donate a blood sample. In other words, participants tend to be more worried than non-participants, but this is because they are of a gender and age that predicted being worried in the first place.

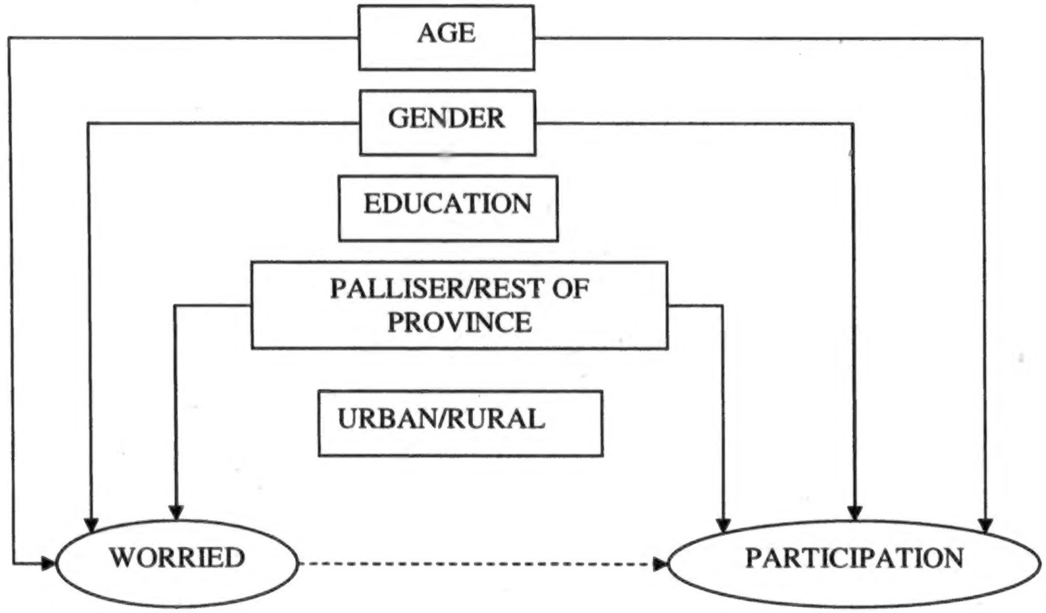

Figure 13: Relationship between demographics, risk perception and survey participation

Not all who agreed to participate in the study have actually donated a blood sample. To what extent non-participation in the second phase of the study might have influenced the seroprevalence results, is a legitimate question. Comparing the telephone survey sample and the seroprevalence sample some demographic differences become evident. To what extent the difference influenced the seroprevalence estimate is worth being investigated. One possibility is to recalculate the estimate readjusting the weights to account for these differences. I believe that the presence of these demographic differences alone does not necessarily mandate this course of action. This would be indeed necessary, only if the demographic predictors of participation are also predictors for being seropositives.

Looking at the seropositives' profile, gender, age and level of education were not related with seropositivity. The only demographic variable associated with seropositivity was Palliser/ vs. rest of the province, an entirely expected outcome. On the other hand, the multivariate analysis on participation that we conducted revealed age, gender and residence in Palliser as being demographic variables significantly influencing participation. Further, the effect size for age and gender are small. The largest effect size among the statistically significant variable is for Palliser / vs. rest of province (OR=1.5, 95% CI: 1,19 -1.98).

In summary, predictors of participation were not also predictors of being seropositive.

I therefore consider that more important than the impact of differences in demographics is to assess whether less apparent differences between the survey and seroprevalence sample, might have significantly influenced the seroprevalence estimate. I therefore attempted to investigate potential differences in behaviours between the participants and non-participants in the second phase of the survey. I looked for any differences in risk of acquiring WNV infection due to differences in behaviour. Specifically, I quantified the risk of infection due to non-use of personal protective measures, lack of environmental reduction activities in the home environment and time spent outdoors. Logistic regression was used to identify whether any significant differences in risk were present between participants and non-participants in the second phase of the study. No apparent difference in the risk of acquiring WNV was found between those who donated a blood sample for testing and those who did not. These findings support the validity of the seroprevalence estimate.

6.4. Study results and the theoretical framework

Based on literature review a simple theoretical model was adopted, with knowledge influencing attitudes and attitudes further influencing behaviours, and demographic variables being responsible for differences in both attitudes and behaviours (Figure 2).

This study was conducted from the perspective of public health action rather than a socio-psychological one. The study results therefore were not intended to illustrate any particular theory on health-related behaviours. The literature review aimed to underline aspects which are relevant for public health practice. In this context the simple model described above was considered appropriate to guide the study enquiries and to explain the study results. The adopted model was based primarily on Theory of Planned Behaviour (Ajzen 1985; Ajzen 1991) and Health Beliefs Model (Becker 1974; Rosenstock 1974a; Rosenstock 1974b).

Knowledge was not a predictor for attitudes in the current study. This is explained by the fact that the differences in knowledge, among respondents, and reflected in the knowledge composite measure, are rather related with minor modes of transmission for WNV and to whom is at higher risk for severe complications. The study sample was rather homogenous in knowledge that WNV is transmitted through mosquito bites. I consider that for an assessment of the above addressed attitudes (i.e. being worried about getting WNV, and agreeing with mosquito control measures) relevant is whether the respondents knew or not that WNV is transmitted through mosquitoes, while knowledge about other modes of transmission is less important. Due to sample homogeneity, the study could not detect a link between relevant knowledge in this case (i.e. knowing that WNV is transmitted through mosquitoes) and consequent attitudes (risk perception and agreement with mosquito control measures). It is very likely that with a heterogeneous sample an association between relevant knowledge and attitudes would have been detected.

Risk perception (an attitude) consistently predicted engagement in preventive behaviours. Further, it was the most important predictor (it had the largest effect on all behaviours, among the variables considered). This illustrates the adopted theoretical framework with attitudes (in particular risk perception) influencing behaviours. The impact of attitudes in general on health related behaviours are described by the Theory of Planned Behaviour. Further, the impact of risk perception in particular on health-related behaviours was described by Health Beliefs Model. HBM highlights the importance of the belief in susceptibility to a disease with serious or severe consequences in order to adhere to a recommended prevented behaviour. WNV can have indeed severe consequences, and being worried about getting WNV reflects the belief in susceptibility to the disease. HBM also recognize the importance of so called "cues to action" (e.g. knowing someone who is ill, exposure to education campaigns on behaviour change.

Demographic variables were part of the complex relationship between attitudes and behaviours. Age and gender significantly predicted being worried as well as engagement in preventive behaviours. Both TPB and HBM recognize that a number of demographic variables can influence health attitudes and behaviours.

6.5. Study limitations

Several limitations are inherent with any survey data:

- data collected relies on self-reported information about respondents behaviours; there is no way to objectively confirm this information;
- data collected is recall-based ; respondents were asked about past WNV related experiences, several months after the WNV transmission season and therefore they might have, at times, inaccurately described their behaviours;
- non-responders could differ in relevant ways from responders in their attitudes and behaviours. No follow up was attempted with those refusing to participate in the study in the first place.

The present study is based on secondary analysis; data available was not collected for the purpose of explaining in-depth relationships between attitudes and behaviours.

The survey data consists of many categorical variables, often describing concepts with complex relation among each other, sometimes responsible for overlap of effects. In some instances it is therefore difficult to describe individual effect size.

7. CONCLUSIONS

7.1. Self-perceived health status, attitudes and behaviours

Self reported health status appears to influence both risk perception (being worried) and behaviours related to WNV. The presence of this relationship is a strong argument for including of the self-perceived health status in surveys addressing any particular health attitudes and behaviours. To further elucidate the nature of this relationship more research is also needed.

Health status reflects a general attitude towards one's health and influences attitudes and behaviours that are more particular (in this case the risk perception of WNV and the associated preventive behaviours). Health status did not predict the overall practice of personal protective behaviours related to WNV, but rather the preference for engaging in particular personal preventive behaviours. Our findings suggest that those with a lower self perceived health status tend to worry more about getting WNV and to take extreme measures like restricting outdoor activities altogether. In contrast, those with a higher perceived health status do not restrict their outdoor activities, but are more likely to continue being active and spending time outdoors while protecting themselves with mosquito repellent.

Knowledge and awareness of WNV threat represent necessary but not sufficient conditions for the practice of personal protective behaviours.

Risk perception has a significant impact on behaviours; being worried about getting WNV consistently predicted engaging in personal protective behaviours. Risk perception also appears to influence agreement with mosquito control interventions.

Demographic variables are part of a complex relationship between attitudes (risk perception) and behaviours. Gender and age differences are present in WNV risk perception, with females and older respondents being more likely to report being worried.

Gender differences also vary across hazards. The current study findings suggest that females are more worried about getting WNV than males, but perhaps even more worried about the potential hazards associated with the use of pesticides, and therefore less inclined to agree with the implementation of mosquito control programs.

Living in an area of high risk for WNV infection (i.e. Palliser) has also significantly predicted being worried about WNV. Level of education was not a significant predictor for either attitudes or behaviours.

The study results accord with the theoretical model, in which attitudes (risk perception) influence behaviours, and demographic factors are associated with differences in both attitudes and behaviours. The study results did not reveal any impact of knowledge on either attitudes or behaviours.

7.2. Survey participation

Participation in the second phase of the survey (donation of a blood sample) appears to be influenced by demographic characteristics (gender, age, education and place of residence).

As expected, participation was higher in Palliser Health Region, compared with the rest of the province. Disease levels were higher in the region, and residents were more likely to know others, who had been affected by the disease. The news media had also a higher level of interest in the WNV topic. These factors showed that WNV topic was considered of importance and contributed to a higher level of participation in the survey.

Having a blood collection site available at the place of residence did not influence participation, a finding which is particularly noteworthy for rural areas.

The results of the present study support the validity of the AHW study seroprevalence estimates. Firstly, demographic differences related to non-participation in the second phase of the study did not impact on the seroprevalence estimates as these demographic variables are not also associated with seropositivity. Secondly, no difference in the practice of preventive behaviour, time spent outdoors and exposure in the home environment was found between participants and non-participants, suggesting a similar level of risk of acquiring WNV.

8. RECOMMENDATIONS

8.1. Future surveys

Given the novelty and continuous evolution of WNV in the Western Hemisphere, regular and enhanced surveillance efforts are needed to further document its impact. In this context the AHW study, the largest assessment of WNV infection in Canada to date, has documented the impact of the first year of WNV activity in Alberta. The current seroprevalence estimates can form a baseline rate, and repeated estimates will be needed over time to fully document the evolution and impact of this particular pathogen as a public health issue in Alberta.

The AHW study has also described the level of knowledge, attitudes and behaviours related to WNV among Albertans, and the results have already influenced preventive and control strategies in the province.

As similar enhanced surveillance initiatives are very likely to be repeated in the future, several relevant aspects will be presented, based on our experience with designing and conducting this survey.

While the usefulness of this kind of survey is evident in informing public health action, it should be mentioned that its effectiveness resides in the quality of information provided.

Careful study design is required, starting from clear objectives and continuing with detailed planning of methods and activities involved.

A particularly relevant aspect for the success of such a survey is related to study participation. Poor participation can affect the validity of the study results. In order to increase participation the following aspects should be considered.

An important determinant for participation is the relevance of the topic for the potential participants. Due to the novelty of WNV, and the attention given by the media to the topic, many Albertans viewed it as important, and therefore agreed when asked to participate in the study. Participants were particularly interested in the results of the study as they were able to find out whether they were infected or not. A unique aspect of this survey was that the respondents were contacted by the regional health authorities in the case that they tested positive for WNV. In general, it is also advisable to make the study known in advance, to explain to the public its importance, and to define how it will be conducted. Respondents are more likely to agree to participate if they had already heard about the study and know that a legitimate institution is conducting it. Future surveys will not have the advantage that WNV is novel and frightening because is novel; therefore more effort may be needed to ensure good participation. Special consideration should be given to making the survey known in advance and to finding new ways to motivate participation.

Another determinant is the careful planning of data collection. It is very important to employ an experienced interviewer team and to schedule interview times to best accommodate population characteristics. In the case of telephone surveys, several attempts at different times are recommended before dropping a telephone number as non-response. The data collection process should be carefully monitored for quality assurance and participation. Follow-up with participants is essential to increase participation. For this study we created personalized follow-up letters, and also included WNV informative materials in the mailing.

Communication with study participants is of paramount importance at all stages of the study. Information about the study should be available to the participants at all times. Interviewers should be provided with relevant information to enable them to respond to any anticipated concerns from respondents. We provided interviewers with a list of frequently asked questions in order to facilitate responses to respondents' enquiries. The members of the study team should be available to respond to any enquiries and concerns from respondents. It is more than good practice to thank respondents for agreeing to participate. Acknowledging participation and highlighting the importance of the study whenever the opportunity arise, motivates participation. Publicly announcing the results of the study, and once again acknowledging respondent's contribution is recommended. Respondents thus gain a sense of participating in a worthy cause, by knowing that their effort to volunteer had produced some useful results.

Once the study is completed, an important issue is the assessment of the impact that non-participation may have on the study results. In our study, males and respondents of younger age were less likely to participate in both study phases. Identifying the demographic differences between the intended and the actual sample is but the first step. Less apparent differences between participants and non-participants may exist and impact on the validity of the study results. In the present study I investigated whether behavioural differences were present between respondents and non-respondents in the second phase of the survey. The main point is to assess the differences in variables which are associated with the outcome variables.

No attempt was made to investigate refusals in the telephone survey. Valuable information can be gained in the future by attempting to record some demographic data from non-participants.

In summary the main aspects related with survey participation that should be considered are:

- what factors affect it
- how it can be increased
- how does non-participation affect the validity of the results (or in other words which are the study limitations, and what valid inferences can be made from its results).

I consider that future assessments of WNV activity in Alberta should follow the pattern of the present study. Combined assessments of seroprevalence and behaviours/ attitudes are mandated to better inform decision making in preventive and control interventions. Seroprevalence assessments should be based on similar study designs which can provide provincial estimates, but also comparisons between various strata (i.e. urban/rural, areas with high/low WNV activity, etc.).

In regards to assessment of attitudes/behaviours, several aspects should be considered. Firstly, the aim of the survey instrument is to provide data that can inform education campaigns. Resources are always limited, therefore a "nice to know "questionnaire cannot be feasible. Clear objectives should be stated, as first step in designing the survey instrument, in order to enable collection of relevant information. The domains included in the current questionnaire, are very likely to remain relevant in the future: knowledge, attitudes and behaviours. Attitudes, risk perception and consequent behaviours change continuously therefore need to be periodically assessed.

Secondly, based on the results of the current study, I consider that some of the survey topics should receive more attention. Risk perception is constantly predicting behaviours; therefore this topic should be investigated in more detail, whenever possible. It is interesting to analyse the WNV perceived risk in comparison with other competing health related risks, particularly the perceived risks associated with the use of repellents and mosquito control measures. Also, the demographic differences in risk perception should be documented as a base for designing more individualized educational messages. In regards to behaviours assessment, I consider particularly relevant, to focus not only on measuring how consistently respondents engage in personal protective measures, but also on identifying what are the barriers for not using them. A structured interview, with close-ended questions is undoubtedly the choice for a large sample. None the less, if considered feasible, a semi-structured interview, administered to a subsample of respondents, can provide depth in understanding the relation between risk perception and behaviours. This approach could make the survey results even more valuable in informing education campaigns.

8.2. Evidence-based WNV public education campaigns

WNV infection can have severe health consequences, and in the absence of any specific treatment or vaccine, public health authorities are responsible to promote primary prevention through public education initiatives.

Any successful public health intervention is an evidence-based endeavour. Each intervention is based on in depth understanding of the current knowledge in the area, but to ensure its success, mere replication of a previous effective action is not enough. Public health interventions in general and education campaigns in particular, should be tailored to local characteristics. For this reason, surveys investigating public perceptions and behaviours provide invaluable data, necessary for both the design and evaluation of a public education campaign.

With data from WNV surveys inquiring about knowledge, attitudes and behaviours, better education campaigns can be designed. These surveys can detect areas of inadequate knowledge, misconceptions and concerns related to the topic. Education campaigns should be conducted periodically in order to provide information and to maintain awareness about WNV.

Based on the results of current study, several aspects relevant for future WNV public education campaigns are further described.

Education initiatives should be based on a good understanding of the relationship between knowledge, attitudes and behaviours.

The current study highlighted the central role of risk perception in predicting behaviours. Therefore periodical assessment of risk perception is mandated, and this information should be used in designing the campaign. What needs to be known is where the target population stands in terms of WNV related perceived risk, within the broader context of health related issues. Further, it is important to know the differences in risk perception across demographic strata and across competing hazards. This has an impact on further risk communication, and the methods used to deliver the educational message. The more worried the people are, the more likely that they will be receptive to a health message teaching them how to eliminate the threat. Differences in risk perception across demographic strata mandate audience segmentation for creating individualised messages; people are more likely to respond positively to a message that is considered relevant for them. Particular attention should be given to further target populations at risk: the elderly and the immunocompromised.

The message that people receive should be clear, highlighting the threat that WNV represents for their health in particular, and also provide clear advice on the preventive behaviours that minimize the risk of disease.

In the case of WNV, a situation of competing perceived risks is present; the recommended preventive and control measures (i.e. repellents, and mosquito abatement measures) are themselves perceived as posing a risks to health. Many respondents appeared to not have clear information about the issue, and considerable number expressed concerns about their safety. Repellents are perceived as chemicals, with an associated negative image. Therefore, clear information should be provided about effective repellents and any safety related concerns should be addressed. A clear description should explain what they do, what are their proven benefits in the context of WNV threat, what products are available on the market, which are effective, how they should be used. Although the majority of Albertans favour the use of mosquito control programs in their communities, more information should be provided prior to their implementation. Respondents disagreeing with these programs reported as reasons the concern with pesticides use, and not having enough information about their safety. These concerns should be further documented and addressed. Again, information should be provided in a clear format, and should explain the differences between larvicides and adulticides, and their respective health risks (with larvicides ensuring a much lower risk for human exposure).

There is good awareness among Albertans about WNV and good knowledge about the main mode of transmission (mosquito bites). Unfortunately awareness and knowledge are necessary but not sufficient for constantly engaging in preventive behaviours. Therefore future campaigns, although not easy to attain, should aim to increase effective use of preventive measures. Barriers to compliance with preventive measures should be identified and addressed.

WNV was a new topic in Alberta, and received increased attention in media, compared with other health issues. This undoubtedly facilitated responsiveness to educational messages. In the future, as the advantage of novelty may no longer be present, new challenges will appear in capturing the public attention for the educational messages. It is a challenge to present information in a new, unusual way, to attract and maintain people's interest.

Another relevant aspect is related to the dissemination of the educational message. Passive sources of information (broadcast media) are likely to be the most effective tools for public health messaging. Public health institutions should maintain a good relation with media, based on understanding of its characteristics, to maintain its interest in the health topics. News media, which are attracted by current issues, rather than future one, may be more willing to disseminate WNV messaging during the WNV season, rather than in advance.

Last but not least, it should be mentioned that a sustained behaviour change is the aim of most education campaigns, but this is not easily attained in practice. It is apparently easier to increase knowledge, and to produce attitude changes than to change behaviours. The results might be slower than desired in this respect, but perseverance is needed. Education campaigns addressing individual health issues have a cumulative effect, which in time determine the adoption of social values related to health. If society slowly comes to appreciate health as an issue that deserves special consideration, and healthy behaviours are encouraged, this will further impact on the success of specific education campaigns. In other words, if the public is educated to place value on health in general, it will be more receptive to campaigns addressing particular health issues.

8.3 Future research

WNV is still a new and important public health issue, which generated considerable surveillance and research efforts. Evidence continues to accumulate providing a better understanding of its ecology, and long-term impacts on human health.

Surveys of public risk perception, attitudes and behaviours provide data that directly inform public health action (prevention and control measures).

The current study results suggest the need for more research on the complex relationship between, attitudes, behaviours and demographic factors in the context of an emerging infectious disease like WNV infection. The link between self-perceived health status and attitudes and preventive behaviours related to particular health topics deserves future investigation. Health status appraisals in general and self-perceived health status in particular, have received increased attention in recent years, mostly in a clinical research context. From a public health primary prevention perspective, the topic deserves equal consideration. The way in which people subjectively appraise their own health, can further influence the nature of their health-related behaviours; better understanding of this relationship can document specific and therefore more effective public health interventions.

Another issue that deserves more attention is related to the barriers to compliance with recommended preventive measures. A mixed methodology approach, involving qualitative methods, may provide more insight into behaviour determinants, and barriers to engaging in preventive behaviours.

Non-participation is a threat to the validity of a survey results. We consider that more research is needed to describe, beside who is participating in surveys, why they are participating (or in other words what motivates people to participate in health surveys in particular and public health initiatives in general). This aspect is particularly relevant in the context of preparedness and response to emerging infectious diseases threat. Besides reporting survey results, it is also valuable for public health action to record the experience with conducting surveys.

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APPENDIX A

AHW Survey Questionnaire

Questionnaire

INT14: FIRST INTRODUCTORY SCREEN

Hello, my Name is $I and I am calling on behalf of Alberta Health and Wellness. We are conducting a study aimed to increase our understanding of West Nile Virus and to help plan the Province's program of West Nile Virus prevention. The study involves a 15 minute survey that can be completed over the phone and also requires study participants to give a small blood sample for West Nile virus testing. We need to speak to someone in your household who is - 18 years of age or older - has been living in Alberta since July 1st, 2003 (last summer) or earlier - and has had the most recently past birthday? Is that you, or is there more than one person 18 years of age or older? IF NEEDED: More than 2?

INT17: RECRUITMENT AND WAIVER WITH SUBJECT

Participation in this study involves two parts. The first part involves completing a phone survey with Albertans who are also willing to give a blood sample for West Nile Virus testing. If you are interested in participating, I will ask for your name and mailing address. A requisition for blood testing and a list of blood collection sites in the province will be mailed to your house some time this week. The requisition must be taken with you to the blood collection site where a small vial of blood will be drawn and sent to the Provincial Laboratory for testing. Because of the size of the study, respondents would only be contacted if their blood sample came back positive for West Nile Virus and this contact would be handled by the Medical Officer of Health for your Health Region. If you are willing and able to provide the blood sample, then we can proceed right now with a short phone survey about West Nile Virus. Do you have any questions about the study as I have described it so far? TRY TO ANSWER QUESTIONS FROM F.A.Q. AND THEN: Are you willing to participate in both parts of the study?

CONSE: CONSENT

Before I start with the actual survey questions, I want to remind you that your help is voluntary and all your responses are strictly confidential. SAY SLOWLY: You are free to stop the interview at any time. If there are any questions you feel uncomfortable answering, please tell me and I will move on to the next one. May I continue now?

HEAR

The first part of the survey deals with your knowledge about West Nile Virus. Before today, have you ever heard of West Nile Virus?

Yes	
No	LSUM
DO NOT READ: Don't Know	LSUM
DO NOT READ: Refused	

WHERE

Where did you hear about it?
DO NOT READ OPTIONS, CHECK ALL THAT APPLY

- Newspaper
- TV
- Radio
- Friends
- Pamphlets
- Doctors/health care professionals
- Internet

Other: Please specify
DO NOT READ: Don't Know
DO NOT READ: Refused

SOUR
What sources would/do you and your family rely on for information and updates on West Nile Virus?
DO NOT READ OPTIONS CHECK ALL THAT APPLY

Newspaper
TV
Radio
Friends
Pamphlets
Doctors/health care professionals
Internet
Other: Please specify
DO NOT READ: Don't Know
DO NOT READ: Refused

MOSQ
To your knowledge, has the West Nile Virus been identified in mosquitoes in Alberta?

Yes
No
Don't know
DO NOT READ: Refused

PEOP
To your knowledge, have there been people infected with the West Nile Virus identified in Alberta?

Yes
No
Don't know
DO NOT READ: Refused

WORRI
How worried are you about getting West Nile? Are you....
READ SCALE

Very worried
A little worried
Not worried at all
Don't know
DO NOT READ: Refused

LIST
I am going to read you a list of possible ways people can get a disease. As I read each one, please tell me whether or not you think a person can become infected with West Nile Virus that way:

Mosquito bites?
Blood transfusions?
Sexual contact with someone who has WNV?
Organ transplants?

Being in the same room with someone who has WNV?
Contact with dead birds?
Shaking hands with someone who has WNV?

Yes
No
Don't know
DO NOT READ: Refused

AGE

To the best of your knowledge, which age group is more likely to develop severe complications when infected with West Nile Virus?
OPTIONAL READ: Severe complications may require hospitalization and in rare circumstances can lead to prolonged health problems or can be fatal. Examples include brain or spinal cord membrane inflammation...
CONTINUE TO READ IF REQUIRED Meningitis is an inflammation of the membrane around the brain and spinal cord. Encephalitis is an inflammation of the brain. Meningoencephalitis is an inflammation of the brain and the membrane surrounding it.
PICK ALL THAT APPLY

YOUNG CHILDREN - Under the age of 5 years
CHILDREN - Between the ages of 6 and 12
TEENAGERS - Between the ages of 13 and 17
ADULTS - Between 18 and 64
SENIORS - 65 years of age or older
DON'T KNOW
Do Not Read: Refused

LSUM

Thinking back to last summer, at times when you might be bitten by a mosquito, how often did you do the following things?

Restrict your outdoor activities
Avoid the places where the mosquitoes were a problem?
Wear long sleeves and pants?
Wear light colored clothing?
Avoid the times of day when mosquitoes were most active? (if required: Mosquitoes are most active at dusk and dawn)
Wear mosquito repellent?

Always
Most of the time
Sometimes
Rarely
Never
DO NOT READ: Don't know
DO NOT READ: Refused

NORE

If you did not uses repellents, why not?
CHECK ALL THAT APPLY, DO NOT READ

Concerned about the use of chemicals
Perceived low risk of getting West Nile Virus
Did not see mosquitoes
Concern over interaction with sunscreen

Too much trouble
Cost too much
Didn't bother
Other (please specify)
Don't know
Refused

DEET

Did the mosquito repellent you use most often contain DEET?

OPTIONAL READ: DEET is the most effective ingredient used to repel pests like mosquitoes or ticks. DEET does not kill mosquitoes, it just makes them unable to locate people and to feed on them.

Yes	REDUC
No	NODE
Don't know	REDUC
DO NOT READ: Refused	REDUC

NODE

If you did not uses DEET repellents, why not?

CHECK ALL THAT APPLY, DO NOT READ

Concerned about chemical use
Perceived low risk of getting West Nile Virus
Did not see mosquitoes
Concern over interaction with sunscreen
Too much trouble
Cost too much
Didn't bother
Other (please specify)
Don't know
Refused

REDUC

Last summer did you or anyone in your household do any of the following things to reduce the number of mosquitoes around your house?

Put screens on windows or doors that previously had none?
Repaired screens that had tears or holes in them?
Checked and cleaned all rain gutters as required?
Regularly empty or replace pools of standing water? Examples of standing water includes: birdbaths, tires, children's pools or fountains that don't work.

Yes
No
Does not apply
DO NOT READ: Don't know
DO NOT READ: Refused

WORK

On a typical work day last summer (July to September), how much time did you spend outdoors during the following time periods?

Early morning (4 am to 8 am)

Day time (8 am to 5 pm)
Evening (5 pm to 9 pm)
Nighttime (9 pm to 4 am)

NONW

On a typical non-work day last summer (July to September), how much time did you spend outdoors during the following time periods?

Early morning (4 am to 8 am)
Day time (8 am to 5 pm)
Evening (5 pm to 9 pm)
Nighttime (9 pm to 4 am)

AGREE

In Alberta, mosquito control intervention initiated by communities may include draining standing water and using chemicals to keep mosquitoes from hatching (these chemicals are called larvicides). Would you agree to the use of mosquito control programs in your area to reduce the number of mosquitoes?

Yes	PROG
No	WHYNO
DO NOT READ: Don't know	WHYNO
DO NOT READ: Refused	PROG

WHYNO

What are some of the reasons you would not agree to the use of pesticides in your area?

DO NOT READ CHOICES CHECK ALL THAT APPLY

- No insects/pest problems
- Child's health
- Adult's health
- Pet/livestock health
- Environmental protection
- Unsafe/hazardous
- Too expensive
- Not enough information about risks
- Other: Please specify
- DO NOT READ: Don't Know
- DO NOT READ: Refused

PROG

In your opinion, if there is a mosquito control program in your area this summer, would it be important to use personal protective measures?

READ IF NECESSARY: Personal protective measures are things like avoiding places where mosquitoes are bad, wearing long sleeves and pants, wearing light clothing or mosquito repellent containing DEET.

- Yes
- No
- DO NOT READ: Don't know
- DO NOT READ: Refused

LIVE
Do you live within 5 km of a major urban area?
READ IF NECESSARY: Greater Calgary area (Airdrie, Calgary, Chestermere, Cochrane, Okotoks and Strathmore) Greater Edmonton area (Fort Saskatchewan, Leduc, Sherwood Park, Spruce Grove, St Albert, and Stony Plain) Fort McMurray Grande Prairie Lethbridge Medicine Hat Red Deer

Yes
No
DO NOT READ: Don't know
DO NOT READ: Refused

DEMO
The following questions are for grouping our results and will not be used to identify you in anyway.

SEXQ
ONLY IF YOU ARE NOT SURE: It may seem obvious, but we have to ask everyone, are you male or female?

Male
Female
DO NOT READ: Don't know
DO NOT READ: Refused

AGEGR
Which of the following age groups best describes you?

18 - 24 years
25 - 34 years
35 - 44 years
45 - 54 years
55 - 64 years
Over 65
DO NOT READ: Don't know
DO NOT READ: Refused

EDUC
What is the highest level of education you have completed?

Elementary, jr. high or less
Senior high - incomplete
Senior high - complete
College or technical school - incomplete
College or technical school - complete
University - incomplete
University - complete
Graduate degree
DO NOT READ: Don't know
DO NOT READ: Refused

HEALT
In general, would you say your health is...
READ CHOICES

- Excellent
- Very good
- Good
- Fair
- Poor
- DO NOT READ: Don't know
- DO NOT READ: Refused

INT99
Thank you for completing the survey. We will be sending you forms that you will need when you go to the lab to have your blood tested. Do you have any other questions? Thank you very much for your participation. Have a good day/evening. Goodbye.

- End Survey -

APPENDIX B

AHW Study Executive Summary

Executive Summary

This report presents the results from the West Nile virus (WNv) Seroprevalence Study, undertaken by Alberta Health and Wellness during March through June 2004.

During 2003, there were 275 confirmed human cases of WNv in Alberta. For every clinical infection there are likely many more undetected infections in humans since the majority of WNv infections have no symptoms. The study was conducted to estimate how many Albertans had actually been infected with the virus. The study also investigated the knowledge and attitudes of Albertans about WNv and about measures used to protect against infection.

Study participants were recruited by telephone using random digital dialing. The sample was recruited equally from the Palliser Health Region (which had the highest incidence of WNv cases during the summer of 2003) and the rest of the province. The respondents were also sampled differentially according to place of residence to determine whether rural residents are at greater risk of infection.

Potential participants, 18 years and older, were asked to complete a telephone survey and donate a blood sample. The telephone interview used questions adapted from previous studies about WNv in Canada and the United States (US).

A total of 3,780 Albertans responded to the telephone survey. Of these, 2,518 also donated a blood sample. The blood samples were analyzed to determine the prevalence of WNv antibody among study participants. The results were used to estimate WNv seroprevalence in Alberta following the 2003 season.

Seroprevalence results

Overall in Alberta, the WNv seroprevalence rate was estimated to be three in 1000 residents.
This suggests that more than 6,900 Albertans were infected with WNv during the 2003 season. About one in 26 infected individuals became clinical cases, and about one in 142 infected individuals developed severe illness (WNv neurological syndrome) during 2003.

The Palliser Health Region, located in the southeast of Alberta, had the highest seroprevalence rates: 46 of every 1,000 individuals living in a non urban area and eight in every 1,000 individuals living in an urban area had been exposed to WNv.

Individuals who reported they always used mosquito repellent containing DEET were somewhat less likely to be infected with WNv, although this association did not reach conventional levels of statistical significance.

Survey results

Almost all respondents heard about WNv prior to the survey, and the majority was aware that the virus had been detected in Alberta during 2003. This information was most often obtained from television or newspapers. However, a considerable proportion of seniors were not aware that they are at increased risk for severe complications of WNv infection. This suggests that a focused education campaign may be warranted.

The majority of Albertans agree with control measures initiated by communities to reduce the number of mosquitoes. This despite the uncertainty of scientific evidence on the effectiveness of mosquito control programs for reducing the risk of WNv infection. Disagreement, when present, is associated with the belief that hazardous chemicals are used or that not enough is known about the safety of these interventions.

Survey participants were more likely to use personal protective measures if they were:
- worried about contracting WNv;
- spent more time outdoors during risk hours for WNv transmission; and
- female.

In addition, respondents were more likely to use mosquito repellent containing DEET if they were more knowledgeable about WNv and were worried about contracting the virus. Participants also indicated they were more likely to engage in environmental risk reduction activities, such as removing standing water and repairing window or door screens, if they: lived in rural areas; were worried about contracting WNv; and were older.

APPENDIX C

Ethics Approval

Health Research Ethics Board

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ETHICS APPROVAL FORM

Date:	July 2004
Name of Applicant:	Dr. Steve Hrudey
Organization:	University of Alberta
Department:	Public Health Sciences
Project Title:	**West Nile virus seroprevalence study, Alberta 2004**

The Health Research Ethics Board (HREB) has reviewed the protocol for this project and found it to be acceptable within the limitations of human experimentation.

Special Comments:

Analysis of anonymous data collected by Alberta Health and Wellness.

Dr. Glenn Griener, PhD
Chair of the Health Research Ethics Board
(B: Health Research)

File Number: B-310704